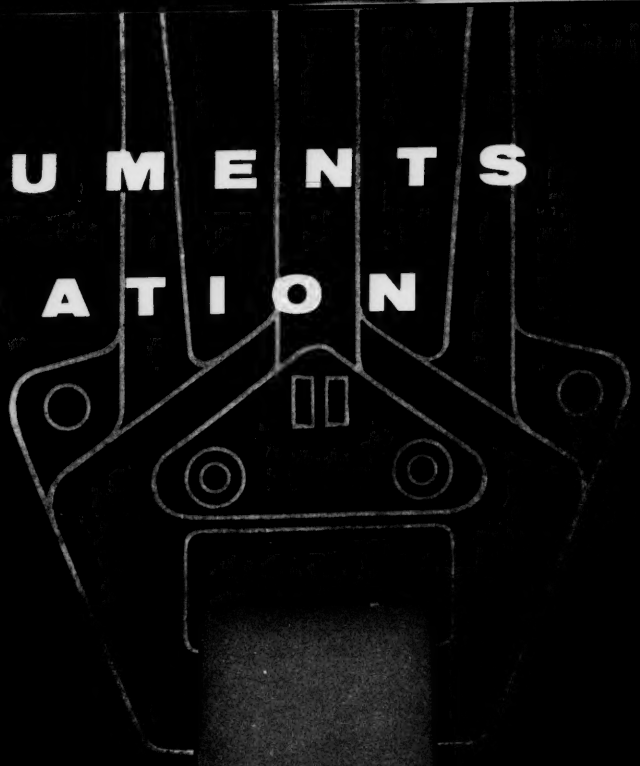
INSTRUMENTS AUTOMATION



INSTRUMENT MANUFACTURING • JOURNAL OF THE SCMA • SIMULATION COUNCIL NEWSLETTER

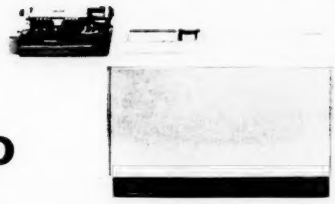
OUR THIRTY-FIRST YEAR

INCLUDING:

iron & steel automation

TODAY'S GREATEST VALUE IN ELECTRONIC COMPUTERS!

ROYAL PRECISION LGP-30



Compare it, feature by feature, with the other computers in its class

Feature	Computer A	Computer B	Computer C	Computer D	LGP-30	
Memory Size	220 words for data only	2160 words	1000 or 2000 words	84 words for data only	4096 words for data & program (either or both)	LARGEST CAPACITY IN ITS CLASS
Max. Speed Add Multiply	 20/sec. 4 sec.	Comparable to LGP-30	Comparable to LGP-30	 3/sec. 1/sec.	 Over 440 sec. Over 50/sec.	SPEED EQUAL TO MANY ROOM-SIZED COMPUTERS
Size	17 sq. ft.	6.5 sq. ft. plus table for typewriter.	45 sq. ft.	9.2 sq. ft. plus table for typewriter & control unit.	11 sq. ft.	COMPACT, DESK-SIZED, COMPLETELY MOBILE
Input-Output	Keyboard only — tape at extra cost.	Independent tape preparation at extra cost.	Extra cost peripheral equipment required.	Tape and typewriter for numerical input-output only. Independent tape preparation at extra cost.	Tape typewriter for alpha-numeric input-output standard equipment.	DELIVERED COMPLETE. NO ADDITIONAL EQUIPMENT NEEDED TO PREPARE DATA, PROGRAM OR REPORTS
No. of tubes	165	450	2,000	248	113	FEWER COMPONENTS MEAN LESS MAINTENANCE, FEWER CHECKOUTS
Voltage	220 V	110 V	220 V	110 V	110V	PLUGS INTO ANY REGULAR WALL OUTLET
Power	2.5 KW	3.0 KW	17.7 KW	1.65 KW	1.5 KW	NO SPECIAL WIRING OR AIR-CONDITIONING REQUIRED
Ease of programming & operation	Not alpha-numeric. No internal program storage.	Alpha-numeric at extra cost. 8 part instruction. Requires computer specialist.	Alpha-numeric at extra cost. Requires computer specialist.	Not alpha-numeric. No internal program storage.	Alpha-numeric. Complete internal program storage. Standard typewriter keyboard. Simplest command structure of all.	EASY TO PROGRAM AND OPERATE.
Cost Sale Rental	 $38,000 $1000 mo.	 $49,500 $1485 mo.	 $205,900 $3750 mo. up	 $55,000 $1150/mo.	 $49,500 $1100 mo.	LOWEST COST EVER FOR A COMPLETE GENERAL PURPOSE COMPUTER

Nation-wide sales and service. Trained staff of applications analysts. Library of subroutines available, plus programs for wide variety of applications.

For further information and specifications on Royal Precision LGP-30, call your nearby Royal McBee office, or write Royal McBee Corporation, Data Processing Division, Port Chester, N. Y.

ROYAL McBEE

WORLD'S LARGEST MANUFACTURER OF TYPEWRITERS AND MAKERS OF DATA PROCESSING EQUIPMENT

For more information circle 1 on inquiry card.

LEWIS

RESISTANCE THERMOMETER AND ACCESSORIES

The Model 62 RT4F Resistance Thermometer is a sturdy, easy to read instrument with a six inch hand drawn scale. It is suitable for use in moving vehicles, is excellent for flight testing or for permanent panel installations. Operated by an ordinary dry cell and calibrated to standard "AN" bulb curves, this instrument is ideal for use with any of the resistance bulbs illustrated below. Other ranges available in °C or °F.

ACCESSORIES — RESISTANCE BULBS AND SWITCHES

Lewis Selector Switches have been used for years in automotive test work as well as in permanent installations. Simple, sturdy construction plus finest materials combine to give long service.

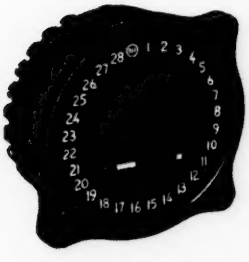
2" SIZE TO 4 POINTS

FREE AIR

3" SIZE TO 20 POINTS

THREADED "AN" TYPE

THREADED "AN" TYPE



4" SIZE TO 28 POINTS

BAYONET TYPE FOR CYLINDER HEAD TEMPERATURE

Lewis Resistance Bulbs are adaptable for use with the 62RT4F Resistance Thermometer or with standard aircraft panel indicators. Special purpose bulbs with stem variations or for high temperature applications are available.

We invite inquiries on your temperature measuring problems.

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Manufacturers of *Complete* Temperature Measuring Systems for Aircraft

NAUGATUCK, CONNECTICUT

Sensitive Research

Versatile POLYRANGERS

THE *Versatile* UNIVERSAL 88 POLYRANGER

88 FULL SCALE RANGES. **DC — 200 microamps. to 1.5 amps., and 20 M.V. to 750 V. AC — 10 M.A. to 3 amps., and 500 M.V. to 750 V. .5% accuracy. For use up to 5 kc. on voltage and 15 kc. on current. 5.2" hand drawn mirrored scale. Automatic temperature compensation. Diamond pivots.**

THE *Versatile* MODEL C POLYRANGER

14 FULL SCALE RANGES. **DC—1.5 M.A. to 10 amps., and 1 V. to 1000 V. Two combinations. .25% accuracy. 6.3" hand drawn mirrored scale.**

THE *Versatile* MODEL DYP POLY-RANGER

20 FULL SCALE RANGES. **AC—5 M.A. to 10 amps., and 5 V. to 2000 V. Two combinations. .3% accuracy. 6.3" hand drawn mirrored scale.**

Inquiries Invited. Write for Bulletin P.

SENSITIVE RESEARCH INSTRUMENT CORPORATION

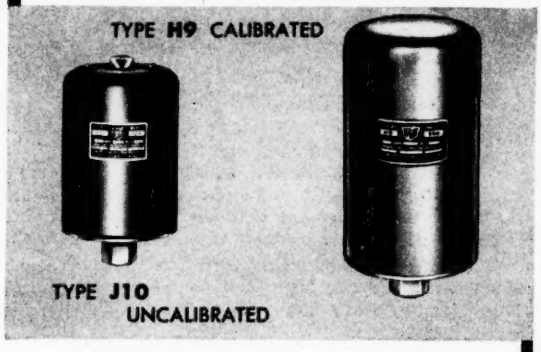
NEW ROCHELLE, N. Y.

Symbol of Quality

For more information circle **3** on inquiry card.

Sensitive H9 J10

PRESSURE and VACUUM CONTROLS



UNITED ELECTRIC's Type H9 and Type J10 controls are highly sensitive precision built pressure and vacuum controls designed for applications where close on-off differentials and constant repeatability are required. Type J10, being uncalibrated, is smaller and less expensive than Type H9 which is calibrated and has a knob & dial adjustment.

Specs:	
Various Ranges	H9-J10 — between 30" Hg. Vac and 15 P.S.I.
Switch Differentials	H9 — ½ to 1 $\pm\frac{1}{10}$" W.C. depending upon model J10 — ¾ to 1 $\pm\frac{3}{10}$" W.C. depending upon model
Switch Ratings	Standardly 3 amps 115/230 A.C.
Switch Types	N.O., N.C., or Double throw, no neutral position.
Electrical Connections	Made to screw terminals on switches through clearance hole in enclosure.
Pressure Connections	One ¼" NPT pressure connection
Size	H9 — 7" x 3⅜" dia. J10 — 6⅛" x 3⅜" dia.
Approximate Weight	H9 — 3 lbs. J10 — 2¾ lbs

UNITED ELECTRIC *manufactures a complete line of temperature, pressure, and vacuum controls. For applications requiring custom-built units or modified standard units, call upon a UE application engineer for recommendations. Write for complete specification and pricing data on the Types H9 and J10. Similar data available on all other UE controls.*

United Electric Controls COMPANY

85 SCHOOL STREET WATERTOWN MASS.

For more information circle **4** on inquiry card.

INSTRUMENTS and AUTOMATION

NO. 2 VOLUME 31

FEBRUARY 1958

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THE MAGAZINE OF INSTRUMENTATION AND AUTOMATIC CONTROL SINCE JANUARY 1928

Instruments and Automation (including Instrument Manufacturing) published monthly by The Instruments Publishing Company, Inc. Office of publications, 1600 North Main Street, Pontiac, Illinois. Executive and Editorial Office, 845 Ridge Avenue, Pittsburgh 12, Pennsylvania. Second Class mail authorized at Pontiac, Illinois.

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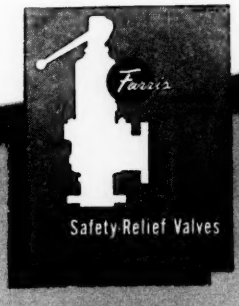
The complete dependability of Farris valves has been proven by 13 years of use in the field, under all service conditions.



Meets ASME-NB Requirements for ASME Unfired Pressure Vessel Code, Section 8 and ASME Power Boiler Code, Section 1.

Send for the NEW Farris Engineering Catalog. A complete, detailed listing of Farris Process Safety and Relief Valves, plus useful information to help you select the proper valve for your requirements.

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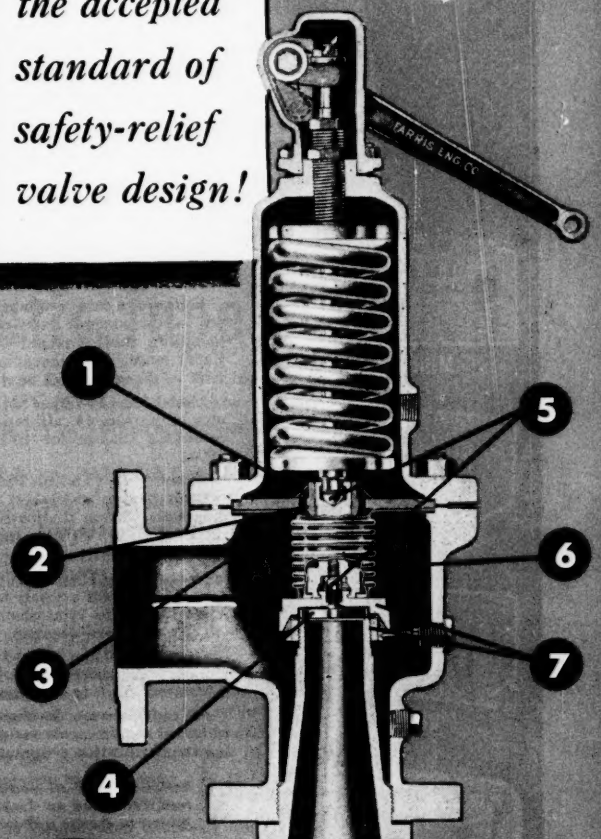
With Farris valves in your process lines you'll know that another confusing design change isn't around the corner to plague you... you'll never worry about obsolescence of your spare parts inventory... you'll always benefit by integrity of materials in valve construction. You can be sure of all this because Farris full-performance valves have proven to be the *accredited leaders* in the field of safety.



1. 2½ to 1 ratio—guide length to guide diameter—prevents galling and hanging up.
2. High thermal expansion ratio of sleeve guide and low thermal expansion rate of hardened stem combine eliminate binding and galling even at elevated temperatures.
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5. Double universal ball joint from stem to disc for self alignment—eliminates effects of spring, temperature and piping distortion.
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FARRIS HYDROTORQUE CORPORATION
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For more information circle 8 on inquiry card.

Measurement Standards

NEW
MODEL 1051
C-R-A-M
UNIT

Calibrator - Receiver - Amplifier - Mixer

The Model 1051 combines four functions. As a 10 kc to 500 mc frequency standard, it delivers sub-harmonics of a 10 mc oscillator to $\pm 0.0005\%$ accuracy. Discrete sine wave frequencies of 10, 50, 100, 200 kc and 1, 2, 10 mc available from rear terminals. Its 5 mc WWV receiver has a sensitivity of 5 microvolts. The amplifier and mixer sections provide a gain of several hundred times and a comparison of external signals up to 1000 mc or a comparison of external with internal signals. Price $760.

MODEL 531

MODEL 541A

MODEL 459

Crystal Impedance Meters

Four units now available to measure resonance and anti-resonance resistance of quartz crystals, including those covered by Spec. MIL-C-3098B. Capacitance, inductance and performance index (PI) of the crystal can be determined.

Model 531 (TS-683/TSM) covers range of 10-140 mcs, employing 13 calibrating resistors and an anti-resonance adapter for 10-150 ohm crystals. Price $590.

Model 541A (TS-710/TSM) for 10-1100 kc range crystals having resistances from 200 ohms to 0.5 megohms. Power dissipated in the crystal is measured. Built-in VTVM and ohmmeter provided. Price $860.

Model 459 (TS-330/TSM) covers 1-15 mc frequency range for crystals having resonance resistances from 0 to 9900 ohms. Price $695.

Model 1207 (AN/TSM-15) covers frequency range of 75-200 mcs for 10-125 ohm crystals. Crystal voltage at series resonance is measured and power calculated. Built-in ohmmeter.

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Performance of all models is rigidly guaranteed. Prices are net f.o.b. Boonton, N.J. and subject to change without notice.

SEND FOR TECH. DATA

For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

RFL *Radio Frequency* LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

For more information circle 6 on inquiry card.

to the editor

Editor, I&A:

W. M. Kidwell's article "Equipment For a Standards Lab" in your November issue was very timely and generated much thought on my phase of the standards field.

Lowell Holcomb
Convair-Pomona
California

Editor, I&A:

We would like to receive tear sheets of the Kidwell article on pages 2064 through 2072 of the November, 1957, issue of *I&A*. These pages would be very useful to us.

Keith Pease
Procurement Coordinator
Test Equipment Department
Pioneer-Central
Bendix Aviation
Davenport, Iowa

Editor, I&A:

The article appearing in your November issue entitled "Equipment for a Standards Lab" proved to be a very interesting and intelligently written subject. The article indicates that the writer, W. M. Kidwell, really "knows his stuff."

Would it be possible to obtain six reprints of this article for distribution among my friends?

Henry E. Ott
Inst. Maintenance & Repair
Int'l Business Machines Corp.
San Jose, Calif.

Editor, I&A:

I must congratulate you on the quality of the articles in your journal during the last year. I think it is achieving a very difficult job of holding its own against the competition.

A. J. Young
Imperial Chemical Industries Ltd.
Reading, Berks, England

We would feel disappointed if we thought we were only "holding our own."

Editor, I&A:

Your editorial in November on education is timely, well presented and factual. I enjoyed reading it and will circulate it here at Arnoux Corp. for those who lack *I&A* subscriptions.

Alvin Kaufman
Arnoux Corporation
Los Angeles, Calif.

Editor, I&A:

I had the pleasure of reading your editorial in *Instruments and Automation*—"Pittsburgh's Answer to Sputnik." I heartily believe that the concept is excellent and matched only by the progress of the project which also seems to be a very high order.

I am using your entire course of study in a high school guidance brochure, *The Scientific Instrument Industry*, which will be published early in 1958 by Bellman Publishing Company, Cambridge, Massachusetts. Lest it come as a surprise to you when the book is out, I do sum up my high praise for your work with the qualification that the curriculum as I evaluated it may be "dug out" of many high school courses of study. In other words, I feel you have made your greatest contribution in doing this digging and actually eliminating such formal course headings as physics, chemistry, general science, etc., and using only the "meat" of such course of studies for your specialized program.

In no way should such a reaction detract one bit from your fine project. The point I want to make is that hundreds of high schools not as fortunate as your Pittsburgh people have the very same opportunities and possibilities if they really want to do something about it. Of course, you will always run into curriculum builders who frown on any such specialized application of certain courses of study material for a specific training purpose, but I personally feel that at the moment there is a need for some down to earth approaches, and your work and that of your committee are to be congratulated for your outstanding efforts.

James R. Irving
Director of Public Information
Scientific Apparatus
Makers Association
Chicago, Ill.

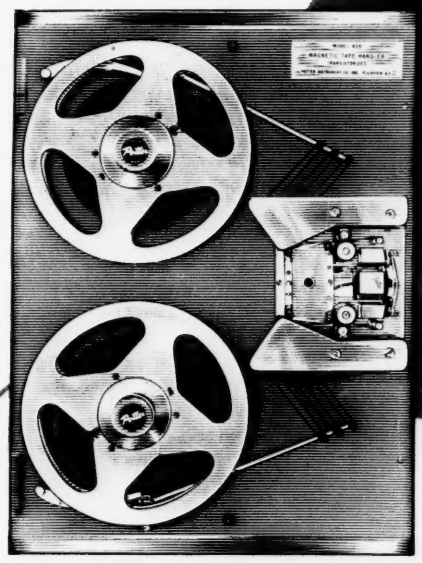
The course is not a substitute for —and is only given in addition to —all normal physics and science subjects in the high school. It is making the formal academic subjects "live" for the students, who are seeing the scientific principles they are studying actually at work.

Editor, I&A:

Your Editorial in November *Instruments and Automation* magazine (Pittsburgh's Answer to Sputnik), is most stimulating.

The plan which you suggested in the article would appear to have a

New...from Potter



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Transistorized Digital Magnetic Tape Handler

Replaceable Capstan Panel permits use as Perforated Tape Reader with a remarkable new brake capable of stopping on the stop character at speeds up to 1000 characters per second.

NEW SPEED • VERSATILITY • RELIABILITY

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- Up to 47 channels
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MST-360

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R1338	P&B SM	4.5 ma	2000	½	Glass	3.75
R1340	P&B SM	15-20	500	½	Metal	3.00
R1341	Teradio	3 ma	10000	1	Metal	4.50
R1441	P&B SM	3 ma	10000	½	Metal	4.00

FILTORS 6C9A: Developed to meet spec MIL-R-5757B; 4-9 VDC; Hermetically sealed; —65°C to +125°C; 50G for 11 millisec contact rating 3 amp. Solder lug connections; 6.3 VDC; 3PDT(3C); 42 ohms; 2.6 oz.

≠R669 ..... 6.50*

FILTORS 26SD18B: Same as Allied MH18D, 26.5 V DC, 6PDT(6C) 200 ohm; 2.2 oz; ≠R1705 ..... 7.50*

FILTORS 26SA12A: Developed to meet spec MIL-R-575A; same as Allied MH12D; 26.5 VDC; 4PDT (4C); 250 ohms; 2.2 oz; Solder lug header; ≠R670 ..... 7.00*

FILTORS 26SC6: Developed to meet spec MIL-R-5757B; Hermetically sealed; —65° to +125°C; 50G for 11 millisec; contact rating 2 amp. Solder lug connections; 26.5 VDC; DPDT(2C); 420 ohms; 2.6 oz; ≠R1306 ..... 6.00*

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48-60 VDC; 3700 ohm; ≠R1701 ..... 7.75*

ALLIED MH12D: 4PDT(4C); 2.9 oz; Operate time: 7 millisec, release: 5 millisec; 26.5 VDC; 300 ohm; ≠R649 ..... 7.00*
48-60 VDC; 3700 ohm; ≠R1702 ..... 7.25*

ALLIED MH6D: DPDT(2C); 1.2 oz; Operate time: 6 millisec, release: 5 millisec; 26.5 VDC; 400 ohm; ≠R665 ..... 6.00*
48-60 VDC; 3700 ohm; ≠R1703 ..... 6.50*

UNION SWITCH UN312200; 27.5 VDC; 6PDT(6C); 250 ohm; 1¾" D x 1¾" H; Plug-in; ≠R1429 ..... 7.50*

UNION SWITCH UN329735; 27.5 VDC; 6PDT(6C); 200 ohm; 1¾" D x 1¾" H; Solder lug header; ≠R1704 ..... 7.50*

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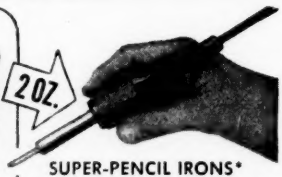
—for fast soldering and long life on constant duty

Because of new efficient design, these tiny tips out-perform irons with larger tips and higher wattages. HEXACON offers a new standard in soldering iron efficiency for every conceivable need in the soldering of miniature assemblies.

Send for new circular No. 127 giving more details and comparative competitive performance data.



SUPER-PENCIL IRONS*
No. 25S 25w. 1/8" tip $6.00
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No. 25H 25w. 1/8" tip $6.50
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PIN-POINT IRONS*
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**Also available in higher wattages*

INDUSTRY'S No. 1 HEXACON SOLDERING IRON

HEXACON ELECTRIC COMPANY
506 West Clay Ave., Roselle Park, New Jersey

For more information circle **9** on inquiry card.

great deal of merit and should be of interest to the development of a better understanding of science and mathematics in our high schools.

I believe that the Superintendents of the some 25 independent school districts of Allegheny County would be interested in hearing more about this plan. Dr. John Linton, Superintendent of the Penn Township Schools, Pittsburgh 35, is president of the Allegheny County Association of District Superintendents. I would suggest that you contact Doctor Linton in regard to your experiment in education.

Earle O. Liggitt
District Superintendent
Munhall Borough School District
Munhall, Penna.

Dr. Linton has been informed of our plans and progress.

Editor, I&A:

I read with great interest the editorial "Pittsburgh's Answer to Sputnik." Congratulations on getting the course under way. The curriculum is one that any high school would be proud of.

In one respect, however, I think your editorial is fallacious. You repeat the common prejudice that "there is a shortage of technical personnel at all levels." Layoffs of competent engineers at Martin, Vertol, North American Aviation and elsewhere indicate that your statement might need qualification. Why don't you do some digging on this question and do an editorial on "Is There An Engineering Shortage?"

James Stern,
International Representative
National Aircraft Department
UAW
Detroit, Mich.

There can be temporary shortage or abundance of engineers on a moment's notice—all the government need do is cancel or add one or two missile contracts. This is not the test of true shortage.

Such a test is found only in our national performance vis-a-vis other countries. With this criterion we have always had a "shortage" of truly superior technical workers at all levels —even when engineers are being laid off. Our modest aim in Pittsburgh is to produce a class that will go into college knowing more about instrumentation than many engineers know when they leave college. Surely there is a shortage of this type of student.

Further, we intend to teach them the necessity for social consciousness and participation in society. We

hope to produce creators of vaccines as well as fathers of H-bombs. Is there a shortage of this type of man? Perhaps this would be better editorial material.

Editor, I&A:

I am the chairman of the Education Committee for the Twin City section of the I.S.A. and am vitally interested in initiating an instrumentation education program in this area similar to the one in Pittsburgh which you editorialized in the November issue of *Instruments & Automation*.

To this end, I would appreciate it very much if I could have some reprints of the Editorial and/or permission to reproduce it and circulate it. It will be a great help in getting a program initiated.

George Keseluk
Minneapolis, Minn.

Material has been sent. Of basic importance is enlisting the aid of all technical societies in your area. Give each one a one- or two-week program covering their fields of specialty. You will end up with exciting programs like those prepared for our Pittsburgh students by the Spectroscopy Society of Pittsburgh, Society for Nondestructive Testing, etc.

Reader Inquiries

Time Control Clock

Engineer in Communications Equipment plant is seeking time control clock operated by 60-cps a.c., running for four hours after power failure. A-294

Wave Height and Level

Manager of instrument sales company desires addresses of suppliers for ocean-wave height and level recorder. A-295

Air Weight Flow

Instrument engineer seeks direct reading air weight flowmeter with range of 0 to 250 lb/min. A-296

Two-speed Electric Clock

Instrument company in England is seeking two-speed electric clock suitable to drive cam one revolution in 4, 6, 8, or 12 hours and able to return it to initial position as quickly as possible. Speed to be selected by control switches. 200-250 volt/50 cycle preferred but 110 volt/60 cycle acceptable. Torque required would be met by heavy-duty chart drive motor. A-297

PRECISION

defined by the dictionary

. . . . "the quality or state of being precise; accuracy; mechanical exactness."

defined by an instrument maker . . .

Swiss American

JEWEL BEARINGS

Sapphire and Ruby Precision Jewel Bearings

FEATURE
- exact tolerances
- high shock resistance
- low friction coefficient

FOR
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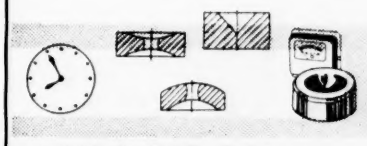

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For detailed information, send specifications or contact

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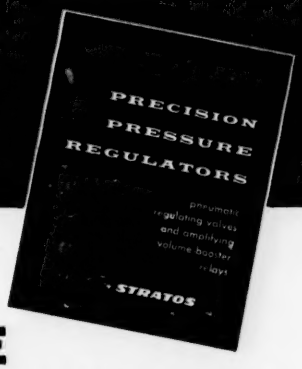

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PRESSURE REGULATORS

The facts you need on a complete range of pneumatic pressure regulating valves and volume boosters. Here is your guide to a series of pilot-operated and direct acting regulators—in pipe sizes from ¼ to ⅜ and ¾ NPT...in supply pressures up to 250 psi. Fact-filled pages spell out the full story: characteristics • pressure ranges, ratios • applications—for 16 different models including motor operated and lever set types.

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A DIVISION OF FAIRCHILD ENGINE & AIRPLANE CORPORATION

For more information circle 11 on inquiry card.

Motor drive gives these miniatures high torque, unusual accuracy

No galvanometer type drive here!

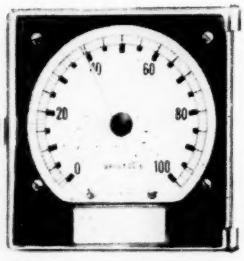
Bristol Series 663 Miniature Electronic Dynamaster* Recorders and Indicators employ a two-phase, motor-driven, slide wire self balancing principle. Here's plenty of torque for operating alarm contacts, electric control contacts, or retransmitting slidewires. Dead band is only 0.15%. Here, too, is twice the accuracy . . . ½% of scale . . . you get in ordinary miniatures.

Full plug-in flexibility, too. You can interchange chassis of the 663 in 10 seconds . . . replace it with either recorder or indicator instruments . . . both plug in easily without tools. Chassis also pulls out to intermediate position for chart changing and inking without disconnecting from circuit. Easy range change, too.

These features simplify planning of graphic control panels. They permit centralized recording and/or indicating of a large number of variables in minimum space. 15 miniatures mount in less space than two full sized units. Human engineering makes 3" charts and dials easy and accurate to read.

Remember, too, only Bristol offers full lines of both full size and miniature instruments. You can count on unbiased recommendations and dependable instrumentation from Bristol. The Bristol Company, 113 Bristol Road, Waterbury 20, Connecticut. 8.12

*T. M. Reg. U.S. Pat. Off.

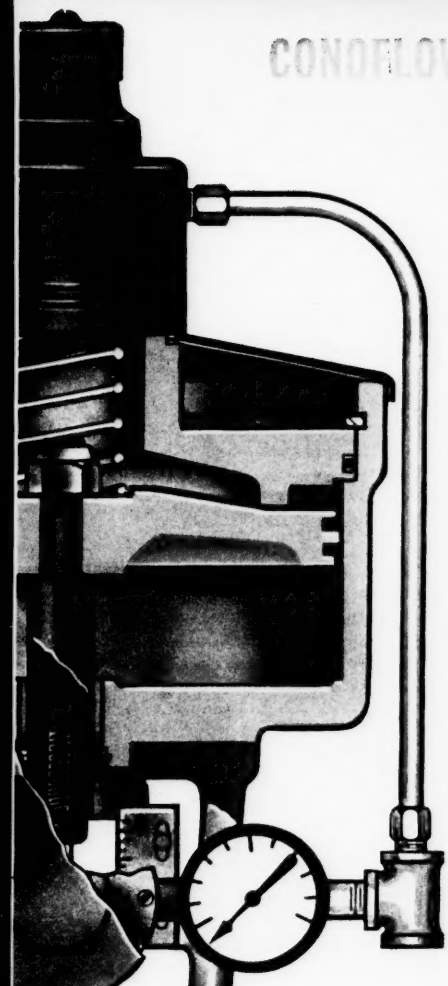


SAME INSTRUMENT also made as an indicator, interchangeable with recorder of similar characteristics in 10 seconds. Actual size: 5" x 5¼".

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **12** on inquiry card.



CONOFLOW LB CONTROL VALVES GIVE YOU

BETTER CONTROL WITH *LESS* MAINTENANCE!

Conoflow LB Control Valves are unequalled for positioning accuracy, power output, speed of response and stability. Yet years of operation have proved that they require much less maintenance than ordinary control valves.

Check these features:

IN THE ACTUATOR . . .

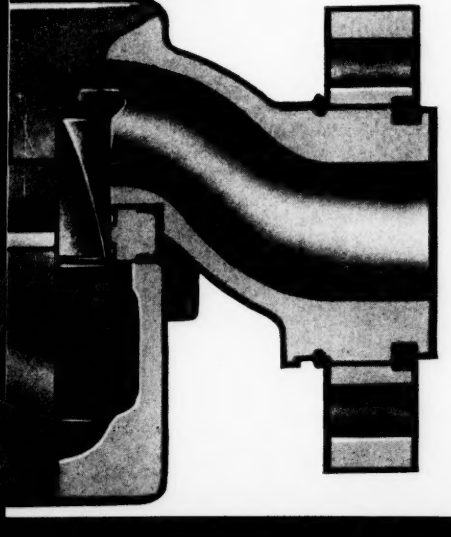
- Cylinder Conomotor piston-type actuator gives 10 to 20 times more power than comparable diaphragm motors.
- New *lipseal* piston-sealing rings will last indefinitely under normal operating conditions, thus eliminating the problem of diaphragm replacement—the main troublespot in diaphragm-type actuators.
- Weatherproof, integral valve positioner affords easy zero adjustment; has no exposed moving parts.

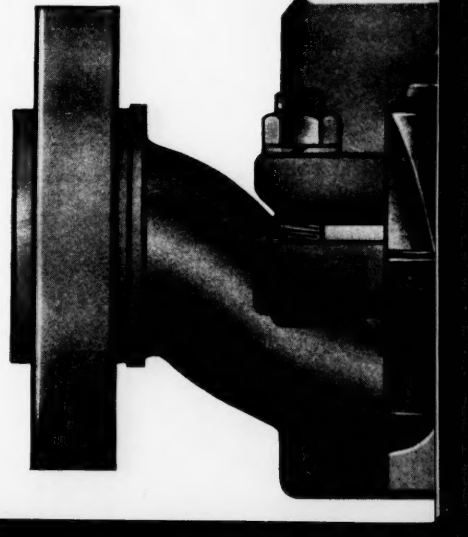
IN THE BODY . . .

- Single-seated split body designed to streamline flow; eliminates cavitational effects and concentrates pressure drop at port opening.
- Integral bonnet does away with leakage at joints; assures positive stem alignment.
- A *really* renewable seat ring; no screwed or threaded insertions to corrode.

IN THE OVERALL DESIGN . . .

Conoflow LB valves give you the best performance characteristics available in any control valve today . . . and in a lightweight and compact unit allowing for easier installation and reduced overall space requirements. If you are not already a Conoflow customer write for Bulletin LB-2-A or for the name of the ConoControls representative nearest you. Conoflow Corporation, 2100 Arch Street, Philadelphia 3, Pa.





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FOREMOST IN FINAL CONTROL ELEMENTS

WALWORTH

For more information circle **13** on inquiry card.

news

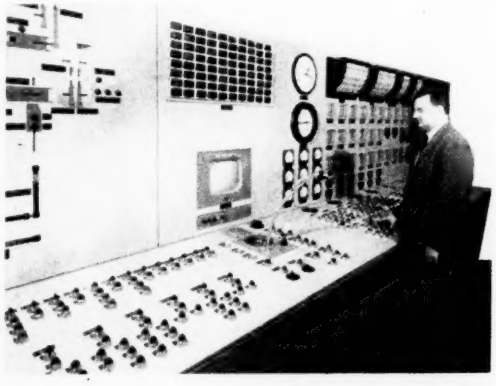
8th Conference on Iron & Steel Instrumentation To Cover All Aspects of Industry

PITTSBURGH, PA.—Instrumentation for the Iron and Steel Industry will be the subject of the eighth annual Conference in Pittsburgh, sponsored by the Pittsburgh Section of the Instrument Society of America. Twelve papers by experts in the field will be read at the three-day event—March 11, 12 and 13—at the Hotel Roosevelt in the Golden Triangle. Afternoons will be held open for demonstrations of instruments and related equipment in company-sponsored exhibit rooms in the hotel. Mayor David L. Lawrence will welcome the guests at the opening session on Tuesday, March 11. A dinner will be held Wednesday evening. For more information see Calendar of Events on page 253.

Automated Sinter Plant

YOUNGSTOWN, OHIO—An electronic control panel, complete with TV screen which gives the operator a continuous picture of the end product, is the nerve center of a fully-automatic sinter plant being built for U. S. Steel Corporation's Youngstown District Works. It is expected to go into operation this March.

In addition to the TV screen, the panel contains the inter-communication system and the trouble signals and controls. The control console comprises two other main



sections. At the left is an illuminated graphic panel which pictures the flow of materials through the plant. Push-button starting controls for all machinery are also located in this section. The right-hand section consists of miniature recorders for raw materials flow, fuel consumption, product output, draft, temperatures, etc., and controllers which adjust the rate settings of each of the different pieces of machinery.

By the end of this year, the steel industry will be able to produce as much as 60 million tons of sinter annually.

Transparent Phosphor Improves C-R Tube Resolution by 20:1

SCHENECTADY, N. Y.—General Electric Company announces that by using new techniques, phosphors now can be deposited on cathode ray tubes by either evaporation or condensation processes. The resulting phosphor layer has the properties of a basically transparent film—by definition, a transparent phosphor screen. The transparent phosphor screen is only 1 - 2 microns thick as opposed to the 15 - 25 micron thickness of standard phosphors.

All phosphors are compared on the basis of the following characteristics: color, persistence, light output efficiency and burn-resistance. Transparent phosphors perform well in all these areas with the additional benefit of uniquely high resolution.

Because of the thin, non-scattering nature of the transparent phosphor screen, there is a theoretical resolution of about 10,000 lines per inch, whereas a standard phosphor screen, with optimum design and operating conditions, permits resolution in the order of 500 lines per inch. In short, theoretical improvement of resolution is about 20 to 1.

Since transparent phosphors are transparent by definition, displays can be made under conditions of extremely high ambient lighting. The normally diffuse reflecting surface of the standard phosphor has been eliminated so that incident light is not reflected. Instead, the incident light is trapped inside the transparent phosphor tube, resulting in excellent contrast.

Redetermination of the Standard Ampere

WASHINGTON, D. C.—Because of the importance of precise electrical measurements the National Bureau of Standards maintains permanent primary standards of two basic electrical quantities, the standard cell for voltage and the standard ohm for resistance. From these, other standards for all electrical quantities are derived—e.g. electric current by Ohm's law. However, a gradual change might sometimes occur in the standard cells or the standard resistors. One method of checking the stability of these standards is to compare the standard ampere derived from them with the "absolute" ampere, that is, the ampere obtained experimentally.

A recent experiment has shown that the standard ampere maintained by the Bureau has drifted no more than a few parts per million in the last 15 years.

HERE'S ONE — MORE TO COME

New Skinner Valves at Low Prices

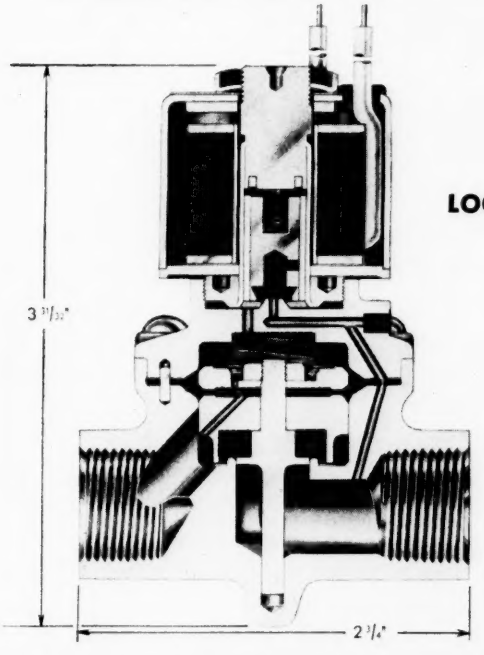
Here it is — one of the many new lines Skinner will bring you in 1958. A new 2-way, normally closed, pilot-operated valve that is lighter in weight — only 1 ¾ pounds — and smaller in size, yet permits full flow through a ½" orifice with ⅜" or ½" pipe taps.

The valve handles pressures from 5 psi to 150 psi, with temperature ranges from —40°F to 180°F, and will operate on all popular AC and DC voltages. It's small but rugged, economical but efficient — manufactured to the highest engineering standards of the Skinner Valve line.

Versatility is also a feature of the new Skinner L Series; modifications are already available for normally open operation, with such options as manual override, explosionproof construction and choice of electrical connections to fit your application requirements.

You can get full details of this exciting, new valve line by writing us direct or by contacting the Skinner Representative or Distributor near you. He's listed in the Yellow Pages. Write Dept. 412.

2-way normally closed shown actual size.



LOOK AT THESE HIGH-QUALITY FEATURES:

- Unique Diaphragm Design — by actual test, this new design outperforms all others — the diaphragm is completely supported at all times. The nylon-reinforced buna diaphragm has a high resistance to media impurities, and only a small area is exposed to pressure, which assures long, trouble-free life.
- So Easy to Mount — so light in weight that it can economically mount directly to line.
- Operates upside down, sideways, in any position — strong spring action snaps valve shut — every time.
- Forged Brass Body — provides low porosity and dense metal structure for rugged application and no leakage.
- Low Wattage Consumption — coil consumes only 8 watts, considerably less than comparable valves.
- Soft, Synthetic Inserts — withstand constant opening and closing of pilot and main orifices — are long-wearing and provide absolute bubbletight operation.
- Internal Stainless Steel Parts — eliminate internal rusting, clogging or contamination.

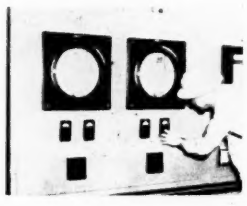
SKINNER ELECTRIC VALVES
THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
105 EDGEWOOD AVENUE

For more information circle **14** on inquiry card.

News Bits

STAUFFER CHEMICAL COMPANY'S Louisville plant uses a unique electronic system designed by **MANNING, MAXWELL, and MOORE,** which operates air actuated valves (purchased from the **ANNIN CO.**) in Stauffer HCL lines. Flow, temperature and pressure readings are transmitted over telephone wires from the metering site back to the plant where they are continuously recorded on flow charts (supplied by **REPUBLIC INSTRUMENT CO.**)

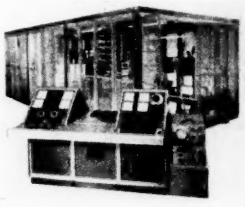


Stauffer panel.

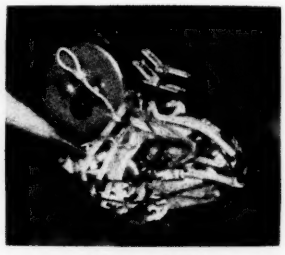
Ira calculates pivots

WELTON V. JOHNSON ENGINEERING CO. INC., sponsors of a contest to determine how many instrument pivots in an ordinary teaspoon, awarded a transistorized portable radio to Ira M. Miller, graduate Forester, whose winning guess was only 14 short of the actual count of 7214 pivots.

MANSON LABORATORIES has built a new 30-megawatt pulse modulator for the specialty transformer department of Westinghouse Electric which tests high-power transformers and simulates actual operating conditions. Picture shows complete testing facility.



Pulse Modulator

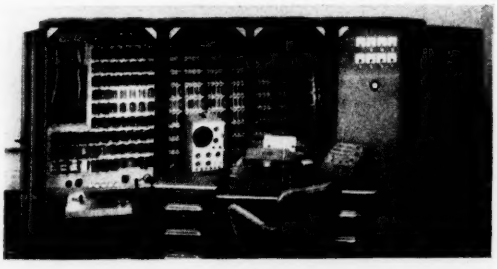


Teflon spaghetti

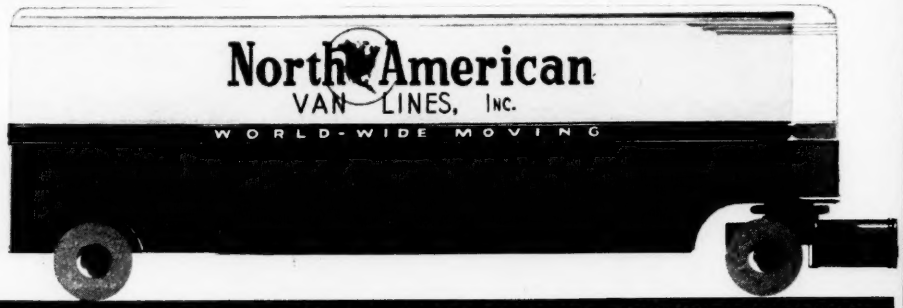
SONOTONE CORP. is successfully insulating sub-miniature instrument parts with Teflon spaghetti tubing and tape supplied by **POLYMER CORP. OF PENNSYLVANIA.**

LEEDS & NORTHRUP supplies the bulk of control room equipment used in regulation of the Experimental Test Atomic Reactor at Arco, Idaho. By recording amount of energy released and neutron concentration, as well as yielding desired amount of energy, the controls free the operator from his every-second job of reactor manipulation, thus giving him time for supervision of overall operation.

save time and money... ship via



Left— Alwac, electronic digital computer, loads *uncrated* into padded van at manufacturer's West Coast plant.
Right—North American's fast, safe service—door-to-door—has customer's unit in operation ahead of schedule.



DOOR-TO-DOOR DELIVERY... UNCRATED... HIGH-VALUE PRODUCTS... EXHIBIT DISPLAYS..

For more information circle **15** on inquiry card.

MINNEAPOLIS-HONEYWELL's Industrial Div. has supplied the instrumentation for France's huge plutonium extraction plant at Marcoule, near Marseille, and will furnish all instruments going into the American-built nuclear research reactors at the Technical University in Munich (Germany), and for the Italian National Committee for Nuclear Research.

SYLVANIA ELECTRIC has introduced a revolutionary new type electric lamp, no larger than a standard flashlight battery, for immediate use in motion picture projectors, and with possible application in automatic controls, infrared heating and microscopy illumination.

WARD SCHOOL of Electronics of the University of Hartford has been accredited officially by the Engineers' Council for Professional Development.

FIRST INTERNATIONAL CONFERENCE ON INFORMATION PROCESSING SYSTEMS is planned for June 1959 at a European location. I. L. Auerbach of Auerbach Electronics Corp. represented the IRE at the recent planning meeting in Paris.

ENGINEERED ELECTRONICS CO. has produced the 100,000th standard-series plug-in circuit—only 4 years from the modest 8,051 sold in 1953.

WEKSLER THERMOMETER recently reached the 250,000-unit mark with its "Adjust Angle" industrial thermometer.

stock report

Any further information concerning any of the following issues may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

	Price Range For 1957-58 Thru January 15, 1958		
	High	Low	Price As of 1/15/58
ACF Industries	64 7/8	36 7/8	40 1/2
Aeroquip Corp.	31 3/8	19 1/8	20 5/8 - 21 (1)
Allis Chalmers	39 1/4	26 7/8	25 5/8
American Comm & Cable	64 1/4	38 3/8	43
American Machine & Foundry	43 3/4	29 1/8	33 3/4
American Machine & Metals	58 3/4	42	49
American Optical	37 7/8	18 3/4	27 1/4
American Tel.& Tel.	179 7/8	160	172 3/8
Beckman Instruments	47 3/4	21	24 7/8
Bell & Howell	50 1/2	36 1/2	45 1/4
Bendix Aviation	66 3/4	42	51 7/8
Boeing Airplane	54 1/8	29	39 1/2
Bullard	29 1/8	9 3/8	12
Bulova Watch	21	9 3/4	12 1/8
Burroughs	52 3/8	27 7/8	30 1/4
Carborundum	51 1/4	28 1/4	48 1/2
Cincinnati Milling Machine	50 1/2	25 5/8	28 3/4
Clevite	25 1/2	15 1/8	17 1/8
Columbia Broadcasting "A"	36 1/8	23 1/2	27 1/4
Consolidated Electrod/namics	34 3/4	25 1/8	32 3/4
Cornell Dubilier	27 1/2	12 1/2	15 3/8
Corning Glass	100 1/4	57 1/4	76 3/8
Curtiss-Wright	47 3/8	23 3/4	27
Cutler Hammer	44 3/4	28 1/2	40
Consolidated Electronics	35 1/2	18	22
Daystrom	47	27 1/2	34
Douglas Aircraft	91	50 5/8	74 3/4
Eastman Kodak	115	81 3/4	99
Eaton Manufacturing	54 1/4	36 1/2	43 1/2
Electric Auto Lite	40 3/8	24 1/2	26 5/8
Elgin Watch	14 1/8	6 5/8	8 1/8
Emerson Electric	34	22 1/8	30
Food Machinery & Chemical	65 1/4	42 3/4	49 1/4
Gearevell	36 1/2	20	22
Garrett	54	23 1/4	30 5/8
General Dynamics	66 5/8	46 3/4	63 1/2
General Electric	72 3/8	52 3/8	62 3/8
General Instrument	8 1/8	4	5 5/8
General Mills	59	36	63 3/8
General Precision Equipment	47 1/4	30 1/4	38 1/2
General Railway Signal	34	19 1/2	23

Continued on page 211

North American Van – UNCRATED!

DOUBLE-CHECK THESE ADVANTAGES:

- **Eliminates costly crating, uncrating.**
- **Saves disassembly and reassembly time.**
- **Door-to-door delivery; no drayage cost.**
- **Proved gentlest in Impact-O-Graph tests.***
- **Prompt pickup, fastest service anywhere.**

*Impact-O-Graphs placed with products shipped via North American van showed far less shock and jar than other methods of transportation. Coupon brings report of findings.

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He's listed in the Yellow Pages under "Movers." Or send coupon below for details of High-Value Products and other North American specialized industrial services, and "Wife-Approved" moves for transferred personnel. North American Van Lines, Inc., World Headquarters, Fort Wayne, Ind., North American Van Lines Canada, Ltd., Toronto.

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North American VAN LINES, Inc. WORLD WIDE MOVING

North American Van Lines, Inc.
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Ft. Wayne 1, Ind.

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a commercially profitable atmosphere for buyer and seller

Through its exhibits and meetings the show and congress can perform a valuable educational service while providing a commercially profitable atmosphere for both buyer and seller.

Program for the Exposition and Congress promises satisfaction for visitors and exhibitors alike. A partial list of reasons is at left.

And, since the National View is focussed squarely on technology—and our supremacy to get there fast, first, and with the most, under serious challenge—this fourth edition of the "original" automation show becomes even more important to individual and industry.

ALL-STAR CHECK LIST
for prospective exhibitors and visitors—

★ **One all-inclusive** "package" price for exhibitors **($5.00 sq. ft.)** covers most "fringe" services for **which exhibitor** usually pays extra.

★ **Attendance expected** to top 25,000 executives, engineers, and technicians.

★ **Exhibitor-sponsored** Clinics on:
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- ★ Process Automation
- ★ Machine Tool Automation
- ★ Office Automation
- ★ Automatic Materials Handling
- ★ Servomechanisms
- ★ Electromechanical Components
- ★ Electronic Components

★ **Automation Congress** comprising nine sessions:
- ★ Data Acquisition and Reduction
- ★ Automatic Weighing
- ★ Machine Automation
- ★ Medical Instrumentation
- ★ Automatic Control Valves
- ★ Military Electronics and Controls
- ★ Importance of Measureme[illegible]
- ★ Product Design for Automation

★ **Three 2-day Conferences** for top-level executives:
- ★ Automatic Data Processing for Senior Executives
- ★ Human Factors in Systems Engineering
- ★ Plant Layout for Automation

4th international AUTOMATION EXPOSITION

and concurrent MILITARY AUTOMATION EXPOSITION

NEW YORK COLISEUM
JUNE 9-13, 1958

FOR COMPLETE DETAILS, WRITE:

RICHARD RIMBACH ASSOCIATES
845 RIDGE AVE., PITTSBURGH 12

For more information circle **16** on inquiry card.

New York Stock Exchange

Continued from page 209

HAUSE & CO

New York Stock Exchange

Pg. 2.	High			Low			Price As of January 1, 1958
General Telephone	42	1/4		35	1/4		41 1/2
General Time	20	1/2		15	1/2		18 7/8
General Tire & Rubber	30	1/8		24	1/8		29 5/8
International Business Machine	726	1/2		570	1/2		702 1/2
International Tel. & Tel.	51	3/4		45	3/4		50 1/2
ITE Circuit Breaker	50	1/8		33			49 5/8
Lockheed Aircraft	53	1/8		36			40 5/8
Litton Industries	46	7/8		29	1/2		42 3/4
Magnavox	44			28	1/8		32 3/8
Minneapolis-Honeywell	134			93	1/2		118 3/4
Minnesota Mining & Mfg.	103			86			97 1/4
Motorola	53	1/4		35	3/4		49 1/2
Mallory	30	1/4		23	1/2		28 1/4
National Acme	60	1/2		40	1/2		46
National Cash Register	70	1/8		46	1/4		66 3/4
North American Aviation	72	1/4		29	1/8		52 1/8
Northrop Aircraft	25	1/8		15	3/4		23 3/8
Otis Elevator	44	1/2		28	3/4		40 5/8
Philco	18	3/8		11			15 7/8
Radio Corp. Of America	40			27			36 1/8
Raytheon	24	1/4		15	3/8		22 1/8
Rheem Mfg.	14	1/4		10			11 5/8
Robertshaw Fulton	31	1/2		20	7/8		28 1/8
Reliance Electric	40	7/8		30	1/2		32
Sangamo Electric	32	1/4		29	1/8		30
Sperry Rand	25	1/8		17	5/8		20
Square D	35	3/4		24	1/8		29 3/8
Standard Coil Products	7	1/8		5	3/4		7 1/8
Starrett (L.S.)	60	1/2		57	3/4		57 1/2 - 60 (1)
Stewart-Warner	41	5/8		27	1/4		31
Sylvania Electric	46	1/4		29	1/4		34 3/4
Tel Autograph	8	1/4		4	1/2		4
Texas Instruments	31	1/2		15	7/8		27 1/2
Thompson Products	84	1/4		40			53 3/4
Tung-Sol Electric	37	1/2		21	1/4		24
Underwood Corp.	21	3/4		12	1/8		14 1/8
Union Carbide Corp.	134	1/2		90			95 1/8
United Shoe Machinery	48	7/8		30	1/4		34 1/4
Western Union	29	3/8		14	1/2		16 1/8
Westinghouse Air Brake	33	1/8		17	1/2		20 1/8
Westinghouse Electric	68	5/8		42	3/8		47
Worthington Corp.	68	1/2		46	1/8		47 5/8

(1) - Not Traded - Bid, Asked

American Stock Exchange

	Price Range For 1957-58 Thru January 15, 1958 High		Low		Price As of January 1, 1958
American Meter	34	1/8	26	1/8	29 1/2-30 (1)
Arc Equipment	22	7/8	13	1/4	14 5/8
Belock Instrument	13	5/8	6	1/4	8 1/2
Benrus Watch	8	1/2	6	1/8	8 1/2 - 8 7/8 (1
Breeze Corp.	8	3/8	5	5/8	5 7/8
Dairy Controls "B"	12	3/4	7	7/8	8 1/8
Clark Controller	31		16	3/8	17
Clarostat Mfg.	5		2	1/2	5 - 5 1/8(1)
Clary Corp.	4	7/8	2	1/2	4 1/8
Dumont Laboratories	8	1/8	3		4 1/4
Dynamics Corp. of America	7	5/8	2	1/2	3 7/8
Electronics Corp. of America	12	7/8	5	1/2	7
El-Tronics	3	7/8	1	1/2	1 7/8
Fairchild Camera & Instrument	27	3/8	16		24 1/2
Globe-Union	20	3/4	16	1/2	16 3/4-17 (1)
Hazeltine Corp.	44	1/2	29	3/4	35 1/4
International Resistance	6	1/8	3	5/8	4 3/8
Lear, Inc	8	3/4	4		5 5/8
National Research	26	5/8	12	1/8	13 1/2
Neptune Meter	33	1/2	18	3/8	21 3/8
New Haven Clock	9	1/8	1	/8	5/16
Norden-Ketay	11	3/4	5	1/4	6 1/8
Nuclear Corp. of America "A"	2	1/4		3/4	1 3/8
Pneumatic Scale	25		16		18 1/2
Servo Corp. of America	8		3	3/4	4 3/4
Servomechanisms	12	5/8	6	1/8	8 1/2
Wallace & Tiernan	33	7/8	23	1/4	26 5/8
Waltham Prec. Instrument Co.	2	1/4		5/8	1 1/8

(1) Not Traded - Bid, Asked

Over-The-Counter

	Quotation as of January 14, 1958 Bid	Asked
Aerovox Corp.	3 1/8	3 5/8
Aircraft Radio Corp.	21 1/2	22 3/4
Argus Corp.	16	16 3/4
Eitel-McCullough Co.	24	25 1/2
Electronics Associates	36 1/4	38
Erie Resistor Corp.	6 1/2	7 1/8
G. M. Giannini	14 3/4	15 1/2
Liquidometer Corp.	4 3/4	6
W. L. Maxson	5	5 3/8
Penn Controls, Inc.	13 1/2	14 1/4
Speer Carbon, Inc.	24	25 1/2
Sprague Electric	25 1/2	27
Taylor Instrument	28	30 1/2
Telecomputing Corp.	3 3/8	4 1/2
Topp Industries	9 3/4	10 1/2
Varian Associates	16 1/2	17 1/8
Vitro Corp. of America	16 1/2	17 1/4

INSTRUMENT ENGINEERS . . .

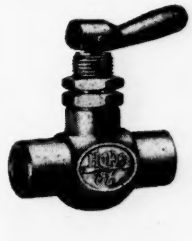
need a small valve on

- GAS ANALYZERS
- TEST STANDS
- AIR GAUGING EQUIPMENT
- GAS CHROMATOGRAPHY
- HIGH VACUUM EQUIPMENT
- GAS TRANSMISSION CONTROL PANELS
- AUTOMOTIVE TEST BENCHES
- OTHER INSTRUMENTATION APPLICATIONS

for quick shut-off

450 SERIES TOGGLE VALVES

Feature quick, flip-of-the-handle action for positive vacuum-tight shut-off. Helium leak tested. Molded nylon handles come in colors for coding instrument operations. Available in brass or 303 SS for 200 psi service in 1/8", 1/4" and 3/8" sizes.



or reverse flow check

570 SERIES CHECK VALVES

Feature extremely effective leak-tight seal, exceptional flow characteristics and low-cost. Synthetic rubber seats and stainless steel springs give maximum corrosion resistance. Available in brass or 303 SS in ball and piston types for 5000 psi service in sizes 1/8" through 1/2"

Why buy big when you can buy small

OK

WRITE FOR CATALOG MV-957

HOKE INCORPORATED

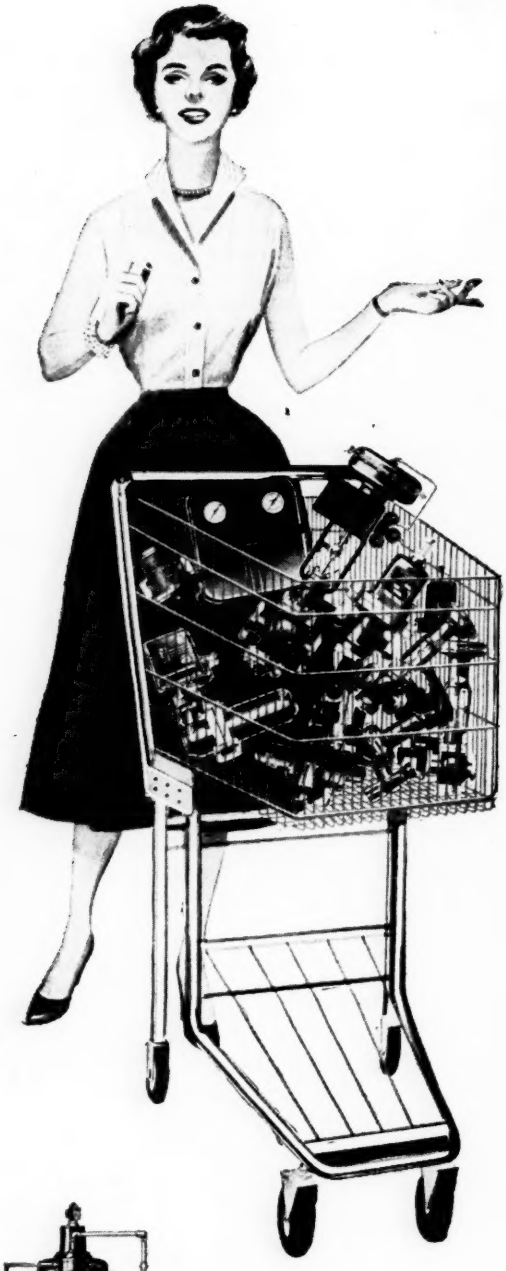
Fluid Control Specialists

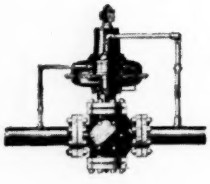
231 South Dean Street

Englewood, New Jersey

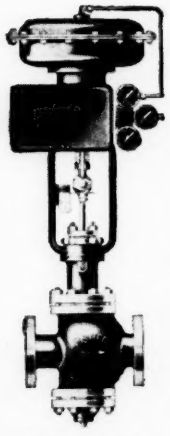
For more information circle **17** *on inquiry card.*

WHAT...a "super market" in this business?



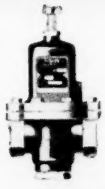


IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... CHANCES ARE IT'S CONTROLLED BY...



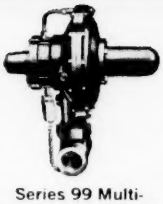
Type 657 with 3500 Positioner

Type 4150 and 4160 Wizard II Pressure Controllers

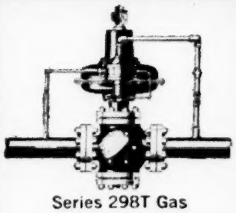


Type 95 Pressure Reducing Valve

Type 630 "Big Joe" Field Regulator



Series 99 Multi-Purpose Gas Regulator

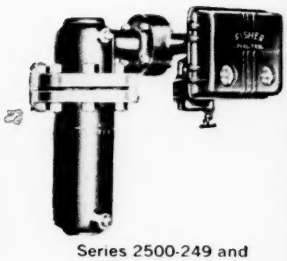


Series 298T Gas Regulators

Type 655-A Pressure Regulator

For more information circle **18** on inquiry card.

YES! *now you can shop by phone, wire or TWX...* for shipment within 36 hours!

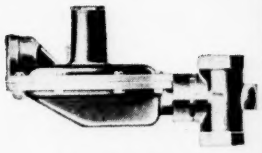


Series 2500-249 and 259B Level-Trols Cage Sizes 14" and 32"

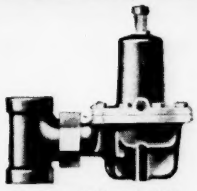
FACTORY STOCK ALWAYS ON HAND:

- Large stock of **DIAPHRAGM CONTROL VALVES**
- Wide choice of **LIQUID LEVEL CONTROLLERS**
- Assorted types of **MULTI-PURPOSE REGULATORS**

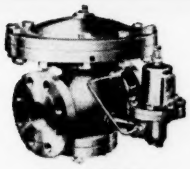
Type 75 Water Reducing Valve



Series S100 and 730 Service Regulators



Series 620 and 621 Farm Tap Regulators



Type 92B Pilot Operated Steam Reducing Valve

Series 67FR Combination Filter Regulator

Fisher's new special service department is organized much like a super market to help you meet emergency requirements with dispatch and speed.

A stock of the popular and standard diaphragm control valves, Wizard Controllers, level-trols and all types of gas regulators are kept on the shelf at all times ready to go.

Every Fisher representative receives a weekly list of all available types for the following week.

Now, when you're up against an emergency, phone, wire or TWX (Marshalltown 578 or 579) the factory or your Fisher representative ... your order will be enroute within 36 hours (except Saturday and Sunday) after it is received in Marshalltown.

FISHER®

SINCE 1880

FISHER GOVERNOR COMPANY

Marshalltown, Iowa/Woodstock, Ontario/London, England

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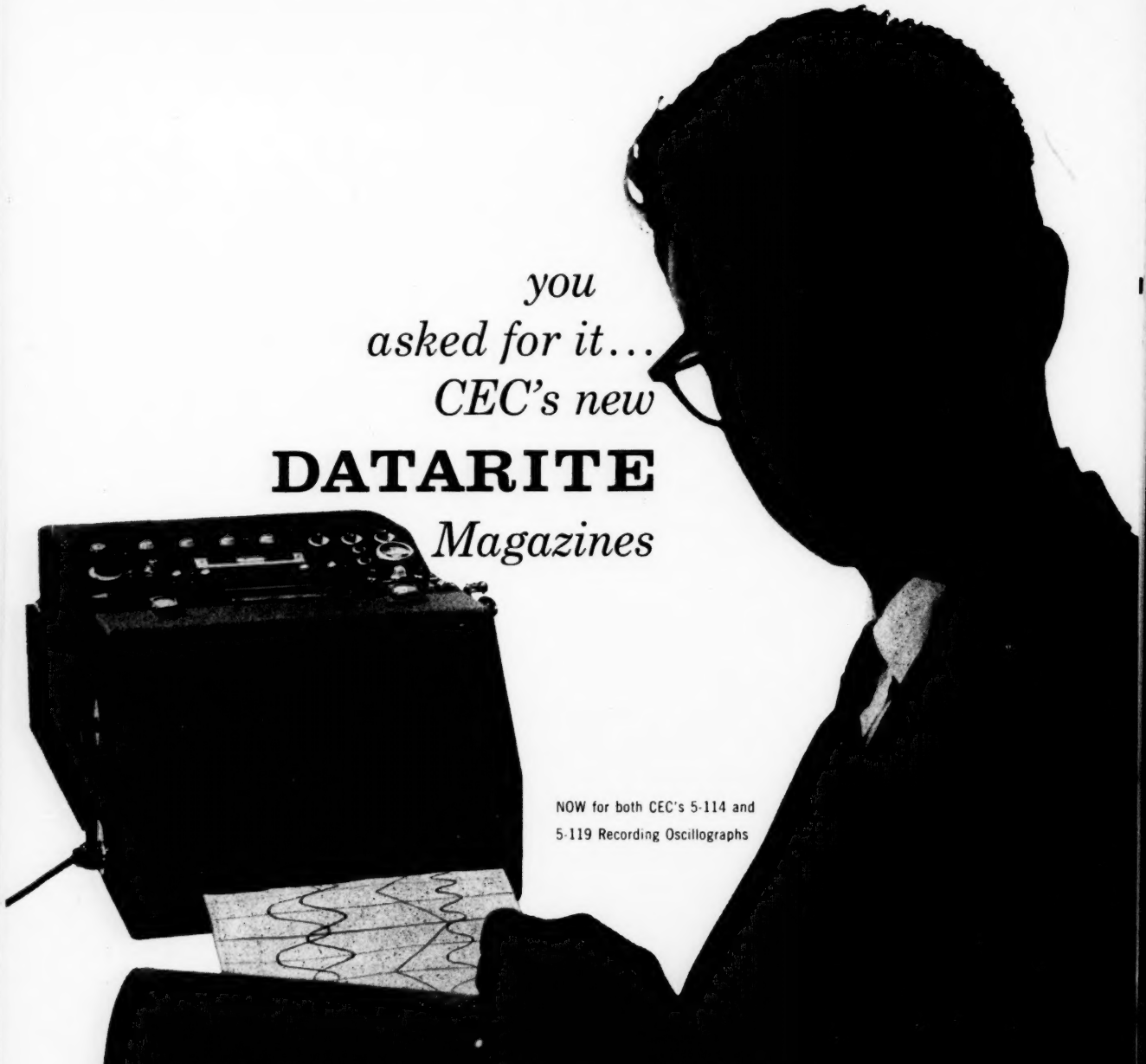


you
asked for it...
CEC's new

DATARITE

Magazines

NOW for both CEC's 5-114 and
5-119 Recording Oscillographs

...examine test results immediately

Rapid-access DATARITE is first to place completely recorded, developed, dried, and ready-to-read oscillograph data into the hands of engineers...*while the test is in progress.* DATARITE's exclusive internal flash-processing yields immediately visible records...no waiting or further processing for records of sharp contrast and resolution over a wide range of recording speeds. Uses standard commercially available recording papers. Provides writing speeds up to 30,000 inches per second. Oscillograms can be duplicated easily by any conventional dry process, including Thermofax and Ozalid.

DATARITE magazine Type 5-047 attaches directly to the versatile 5-114 and Type 5-036 attaches directly to the 5-119 Recording Oscillograph without modifications or adapters. Magazines hold 400 ft. of thin-base recording paper. Record and event numbers are automatically imprinted for ease of data reduction. For complete DATARITE details contact your nearby CEC field office, or write for Bulletin CEC 1598-X12.

Descriptive literature on CEC's Recording Oscillographs: Type 5-114 - 18 and 26-trace models, 7 inch record width - Bulletin CEC 1500-X20. Type 5-119 - 36 and 50-trace models, 12 inch record width - Bulletin CEC 1536-X24.

Consolidated
Electrodynamics

300 No. Sierra Madre Villa, Pasadena, California

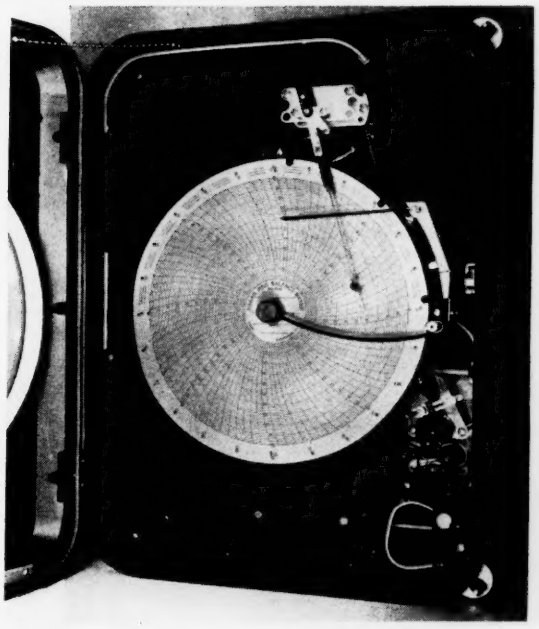
OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

RING BALANCE FEATURES No. 4

ELECTRIC TRANSMISSION

with the versatile new PowrLog

ELECTRONIC RECEIVER



Complete assembly with amplifier in place. Flow integrator may be added for complete records.

The Hagan PowrLog Electronic Receiver brings a new standard of accuracy and dependability to the remote transmission of all standard variables. In applications where the transmitter is a Ring Balance meter equipped with slide wire, the PowrLog receiver can record, integrate and indicate fluid flow with or without compensation for pressure and temperature, fluid density, liquid level in open or closed vessels, boiler drum water level. Used with suitable amplifiers, the field of application widens to include temperature, heat exchange and other variables.

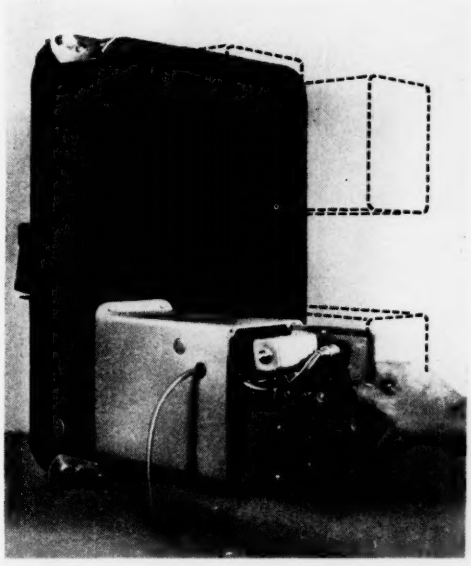
Interchangeable, plug-in, input boxes quickly adapt the PowrLog to operation with AC or DC inputs. Up to four records can be made simultaneously or control can be accomplished through coupling to the Ring Balance pneumatic transmitter-controller.

Unaffected by mechanical friction or power supply fluctuations, the PowrLog offers these operating characteristics:

Resolution	0.15% of full scale
Repeatability	0.25% full scale
Over-all Accuracy	0.5% full scale
Pen Travel Time	2 seconds full scale (0.5 sec./inch)

Input Ranges:

AC Bridge	1000 ohm transmission potentiometer
DC Potentiometer	0-0.1 v. to 0-1.3 v.
DC Voltmeter	500 volts maximum



Printed circuit amplifier chassis slides readily into housing. Note that as many as four units may be used in a single instrument case.

Remember, the Hagan Ring Balance meter offers you all these features, too:

1. Ease of calibration under operating static pressures with factory calibrated check weights matched to each meter. No more four-story water columns and telephones!
2. Safe operation with rings rated at 2,500, 6,000, 15,000 psig. No gaskets, no stuffing boxes.
3. Sealing fluid density and level not critical. No eyedroppers required to maintain calibration.
4. Interchangeable ring assemblies for full scale ranges from 0.5" w.c. to 560" w.c. Adjustment on any one ring over a 7:1 differential range easily and quickly accomplished.
5. Wide range computation and/or compensation by means of built-in, easily checked mechanisms available on most models.
6. Any Ring Balance meter can be equipped with slide wire for operation with data-logging devices and for transmission to the PowrLog.

For full details on the Hagan PowrLog, write for Bulletin MSP 149.

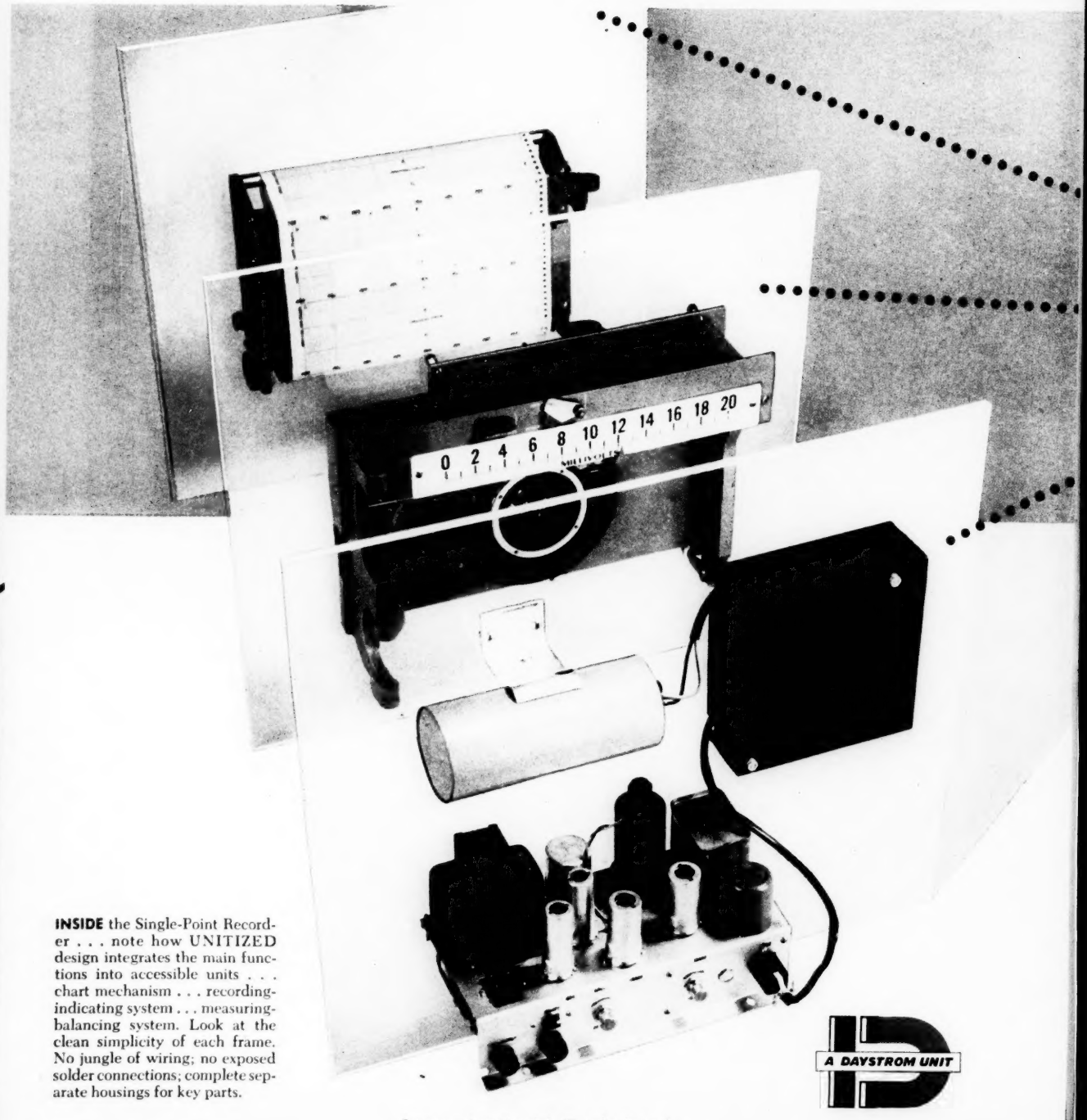
HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO

For more information circle **20** on inquiry card.

← Circle **19** on inquiry card.

UNITIZATION*

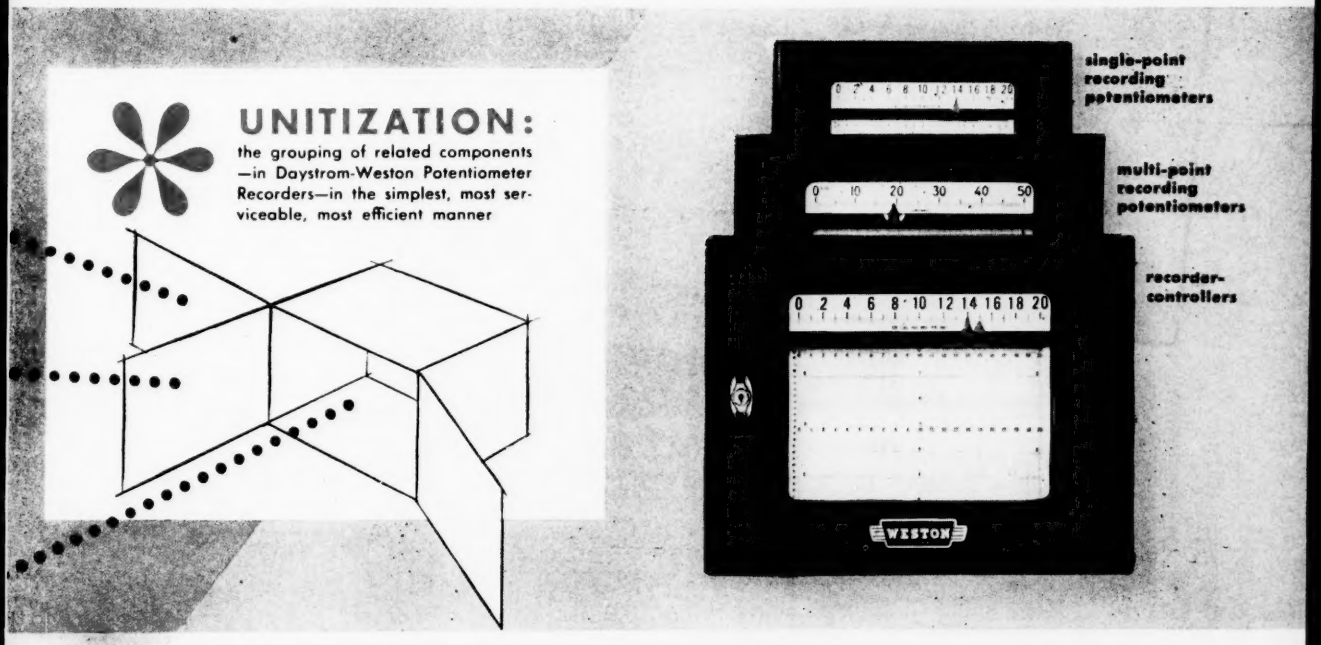


INSIDE the Single-Point Recorder . . . note how UNITIZED design integrates the main functions into accessible units . . . chart mechanism . . . recording-indicating system . . . measuring-balancing system. Look at the clean simplicity of each frame. No jungle of wiring; no exposed solder connections; complete separate housings for key parts.

A DAYSTROM UNIT

For more information circle **21** on inquiry card.

pays off BIG!


UNITIZATION:
the grouping of related components —in Daystrom-Weston Potentiometer Recorders—in the simplest, most serviceable, most efficient manner
single-point recording potentiometers
multi-point recording potentiometers
recorder-controllers
WESTON

GREATER DEPENDABILITY . . . LOWER MAINTENANCE . . . EASIER SERVICING

stem from WESTON's exclusive UNITIZED instrument design!

Trouble-free instrument service begins with design. Weston's unitized design – unequalled for simplicity – makes possible longer, more accurate performance . . . eliminates on-the-line headaches and inconveniences.

• **HIGHEST RESOLUTION** is made possible by use of 2500-turn universal slidewire. No competitive instrument offers a comparable slidewire.

• **GREATEST TIME SAVINGS** in routine servicing: Charts are installed in seconds; pen is filled without removal, and restarts instantly.

• **LOWEST SPARE-PARTS INVENTORY:** Amplifier uses standard tubes; matching is unnecessary. A single amplifier serves all speeds and sensitivities. Slidewires, range standards and alarm components are interchangeable.

• **SIMPLEST MAINTENANCE:** All inspection and servicing is done from the front of the instrument. Entire amplifier can be quickly removed for servicing without breaking any soldered connections.

• **COMPACTNESS:** These are the smallest case, standard chart size potentiometer instruments offering guaranteed ¼% accuracy. Less panel space is required. Instruments mount in standard radio or relay racks.

• **VERSATILITY:** Range standards are instantly changed on exclusive range panel. Chart speeds are changed with a simple screwdriver adjustment. Instruments easily adapt to special equipment, such as alarm circuits.

• **RESISTANCE TO SHOCK,** vibration, corrosive atmospheres: Key components have complete separate enclosures, yet are readily accessible. Shock tests prove instruments practically immune to mechanical damage.

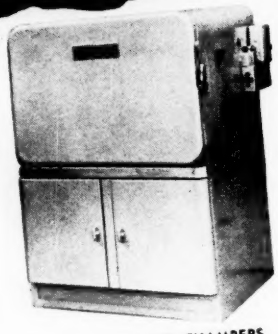
For more complete information, call your local Weston Representative, or write . . . WESTON INSTRUMENTS, Division of Daystrom, Inc., Newark 12, N. J.

DAYSTROM-WESTON

Industrial Instruments

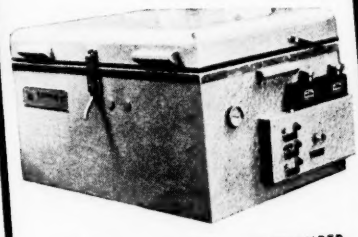
immediate delivery!

Bemco has many types of chambers available for immediate delivery from stock on a rental or purchase basis. WRITE FOR THE NEW FORTY-FIVE PAGE ENVIRONMENTAL EQUIPMENT MANUAL.



HUMIDITY TEST CHAMBERS
8, 12, and 27 cubic foot sizes for MIL-E-5272 testing.

SALT SPRAY CHAMBERS
9 and 30 cubic foot sizes.



WIDE RANGE TEMPERATURE CHAMBER
Model DF-100/650-1 dry ice cooled, electric heat, —100° F. to +650° F. $585.00 F.O.B. Bemco.

BEMCO INC.

ENVIRONMENTAL TEST EQUIPMENT DESIGN AND MANUFACTURE

11631 VANOWEN STREET • NORTH HOLLYWOOD, CALIFORNIA • MEMBER OF THE E.E.I.

For more information circle **70** on inquiry card.

EQUIP FOR THE SIZE OF THE JOB

USE THE PERFECT COMBINATION
For Assured Accuracy
in **MICRO-DRILLING**

SPHINX

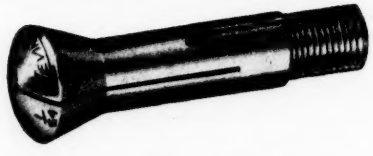
HIGH SPEED STEEL MICRO-DRILLS

Drills from .0016" to .0591" are stocked in increments of .0004"(.01 mm). From.0610" to .1181" in increments of .0020" (.05 mm). Left hand micro-drills for use on Swiss type automatic screw machines. Short flute center drills. Send for Bulletin "Q" listing complete line of drills or Catalog M listing collets as well as full line of instrument lathes and accessories.

Louis Levin & Son, Inc., 3610 S. Broadway, Los Angeles 7, California.

LEVIN ®

SUPER PRECISION COLLETS



Super precision collets for jewelers type lathes. Ideal for holding micro-drills or other parts where concentricity is important. Available from stock in complete range of sizes from .004" (.1 mm) to 5/16" (8.0 mm).

For more information circle **71** on inquiry card.

You don't have to be over 21

to install and maintain

a Fenwal temperature indicating controller

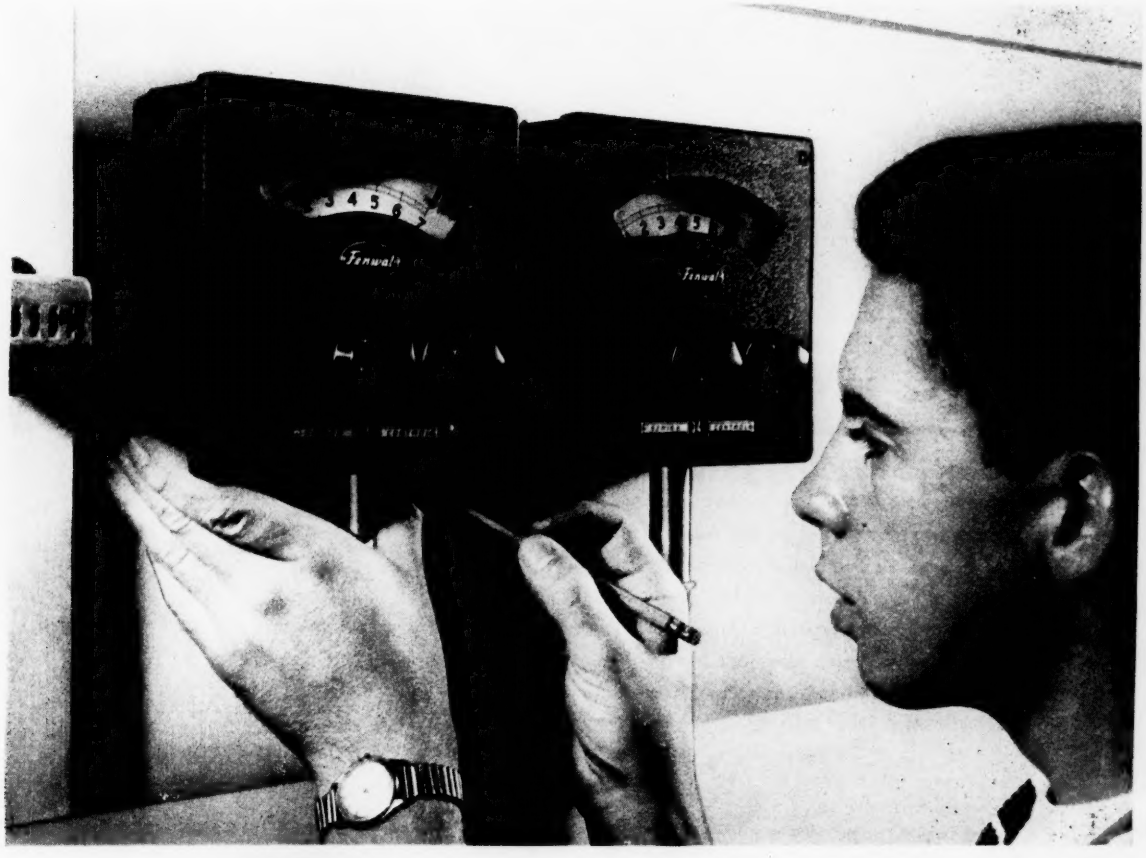
It really is a cinch for an untrained person to install and maintain Fenwal's 541 Temperature Indicator Controller. You don't even have to open the case to adjust it — even its snap switches can be easily replaced without disturbing the internal mechanism. *It's simple!*

In Fenwal's 541 all moving parts are in opposition — wear on one is automatically compensated for and the controller's high accuracy remains unchanged! *It's reliable!*

You can take your choice of temperature range, bulb styles, and one or two circuit controls, current ratings — even the color of the housing. There are literally hundreds of adaptations that can be made from stock! So you get a tailor-made, fit-to-order controller at a competitive price! *It's versatile!*

Drop us a line at Fenwal Incorporated, 362 Pleasant Street, Ashland, Mass. and we'll send you our catalog MC-139 or our sales engineer, whichever you want.

This is our dual circuit model (we've got hundreds of others) which has two snap switches, each with a set point indicator, that actuates two circuits at pre-set temperatures. Housing in all Fenwal 541's meet NEMA and JIC specifications.

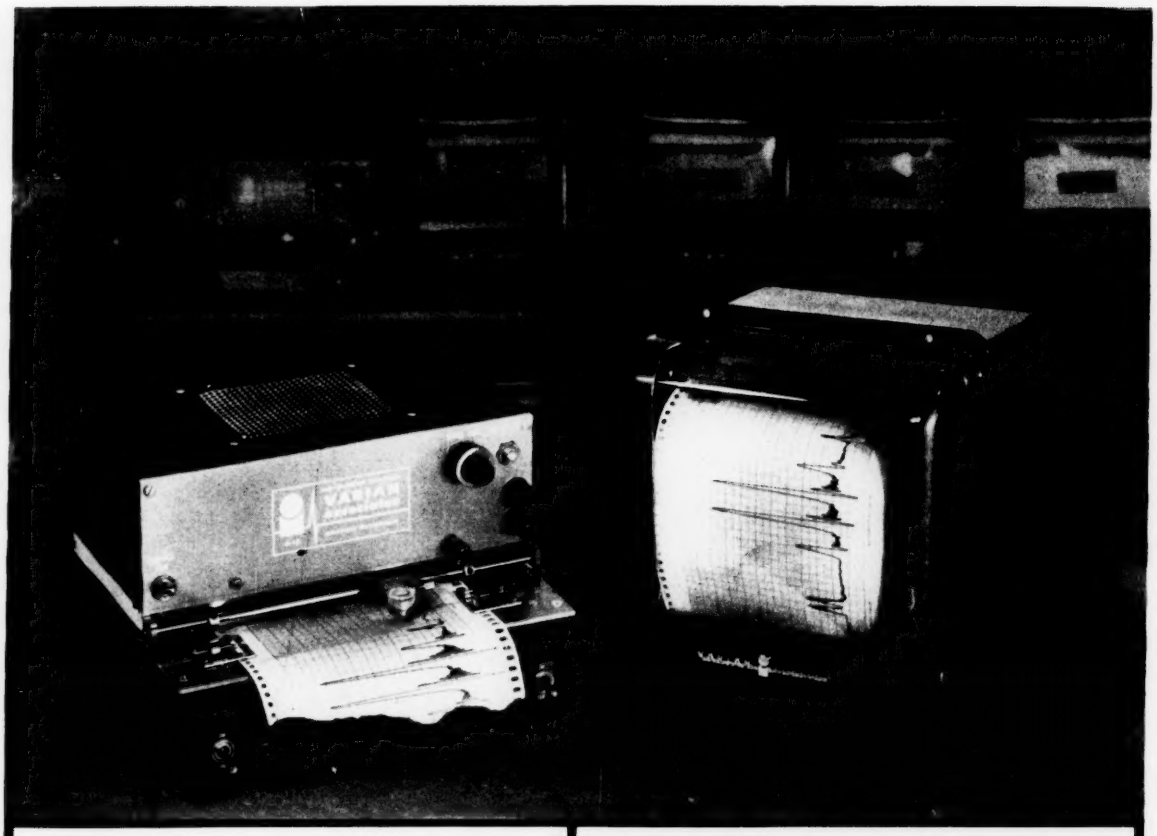


Fenwal CONTROLS TEMPERATURE . . . PRECISELY

For more information circle **22** on inquiry card.

Varian Strip Chart Recorders

POTENTIOMETER PERFORMANCE* AT MODERATE COST



Varian G-10 — Portable for laboratory or bench use where chart accessibility is of prime importance. Base price $340.

Varian G-11A — For panel, rack or portable use; designed for OEM, lab or field for long-term monitoring. Base price $450.

* The servo-balance potentiometer method has long been used in expensive recorders to achieve superior stability, sensitivity, ruggedness and high input impedance. Use of servo balancing systems assures full realization of these inherent advantages by providing ample power independent of the source being measured. Now Varian offers you recorders of moderate cost using this time-proven principle.

VARIAN SPECIFICATIONS:

- Spans as low as 10 mv
- Limit of error 1%
- Maximum source resistance 50K ohms or higher
- Balancing times: 1 second or 2.5 seconds on G-10; 1 second on G-11

WRITE TODAY FOR COMPLETE SPECIFICATIONS

Varian recorders are sold and serviced throughout the free world by representatives in principal cities.

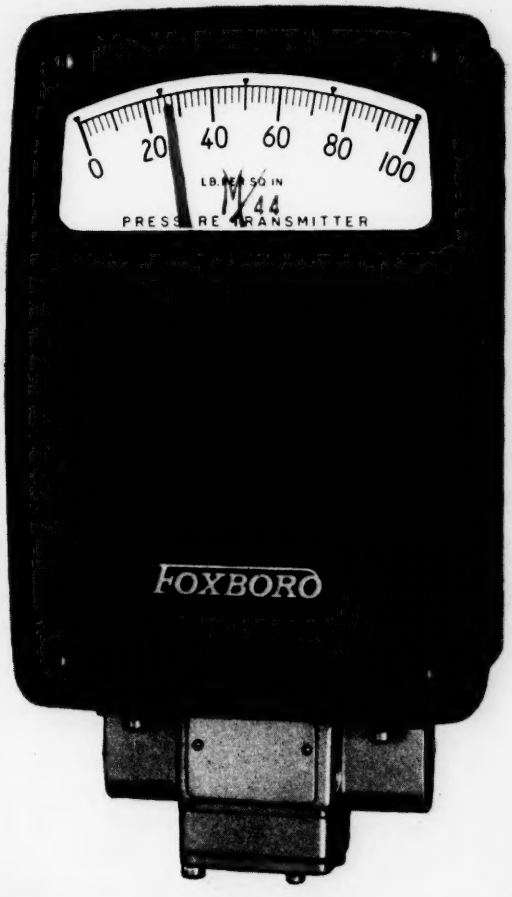
VARIAN associates
INSTRUMENT DIVISION
PALO ALTO 27, CALIFORNIA

Varian Associates manufactures Klystrons, Traveling Wave Tubes, Backward Wave Oscillators, Linear Accelerators, Microwave System Components, R. F. Spectrometers, Magnets, Magnetometers, Stalos, Power Amplifiers and Graphic Recorders and offers research and development services.

For more information circle **24** on inquiry card.

read pressure up to 20 ft. away!

on the FOXBORO M/44 INDICATING PRESSURE TRANSMITTER



You can check pressure readings at a glance on the Foxboro Pneumatic Indicating Pressure Transmitter. Its open-face, horizontal, 4-inch indicator scale and eye-catching red pointer are clearly visible as far away as 20 feet.

But high readability is just part of the story. Actually, this instrument was engineered from the ground up. Makeshift arrangements have been eliminated, hung-on gauges are gone. Everything is included in one, neat, ready-to-install package.

Because the indicating pointer is direct-connected to element and transmitter, calibration is easy . . . and you can re-zero the transmitter externally. All M/44 components are standard, performance-proved Foxboro parts. This makes it easier to stock and service.

From its compact, drawn-steel case to its tough, polyester plastic cover the M/44 is the high-efficiency, low-cost pressure transmitter for centralized control and operation. All standard ranges.

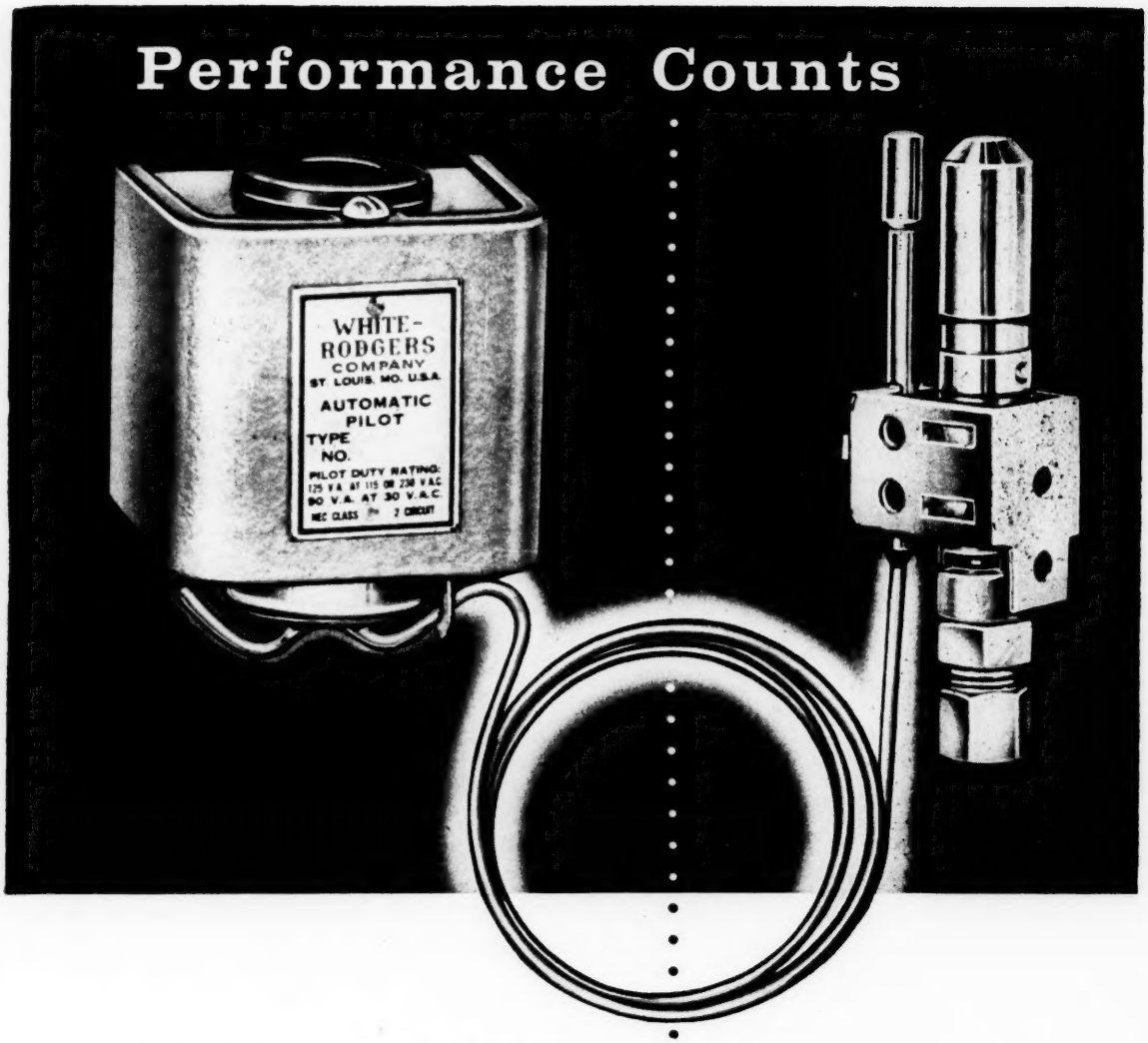
Write for complete details. **The Foxboro Company, 462 Neponset Ave., Foxboro, Mass.**

FOXBORO INSTRUMENTATION FOR INDUSTRY

REG. U.S. PAT. OFF.

For more information circle **25** on inquiry card.

Performance Counts



White-Rodgers Co. selects BISHOP #347 CBTA **CAPILLARY TUBING** with an .078" OD and .031" ID for dependable performance in its automatic *Safety* pilots found in the majority of today's gas clothes dryers . . . another typical application of BISHOP *quality* tubing by today's instrument manufacturers.

For *accurate, dependable performance* of your instruments, specify BISHOP tubing.

Catalog on request.

Capillary, Mechanical, Hypodermic Seamless and welded and drawn Tubing
(.008" to 1" OD – .003" to .083" Wall)

Nickel and Nickel Alloy Tubing
(up to .625" O.D.)

STAINLESS STEEL PRODUCTS DIVISION

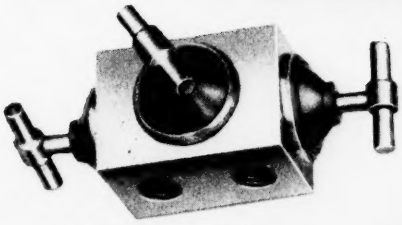
J. BISHOP & CO. Platinum Works

Malvern, Pennsylvania

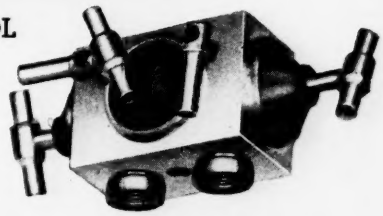
For more information circle **26** on inquiry cards.

Packless "DEMI" Valves

FOR MINIATURE CONTROL FROM PILOT PLANT TO PROCESS

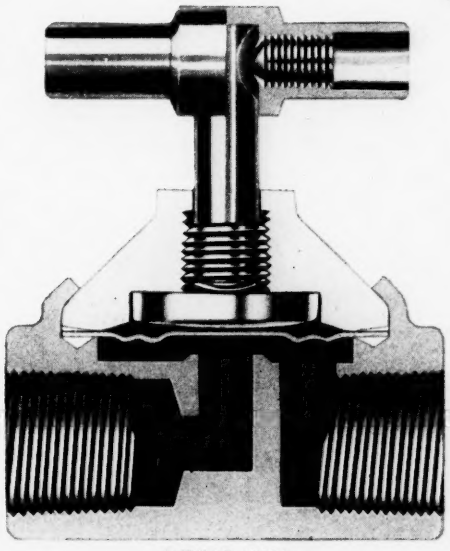


34-1 Compact Packless 3-Valve Manifold for meter and manometer applications (2-block and 1 by-pass valve ¼" NPT).

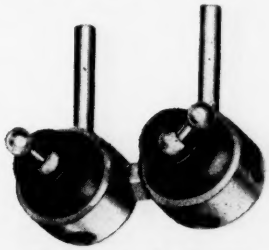


54-1 5-Valve Manifold designed for direct mounting on Miriam B-1103 manometer (2 block valves, 2 vent valves, and 1 by-pass valve).

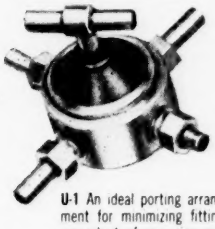
H1-2 Two or more joined together with standard ⅛" pipe nipples form a header with individually controlled outlets, with single direction toggles which indicate at a glance which valves are open or closed.



PATENT NO. 2,812,777



H2-1 Special porting allows this model to be assembled in multiple numbers forming their own header. Two common ports are opened simultaneously when the toggle is tilted (⅛" NPT and ¼" tubing extension).



U-1 An ideal porting arrangement for minimizing fittings, equivalent of one pipe cross with one controlled outlet (shown with tube ends).

This basic patented packless design is employed in the designs shown, as well as many other variations available for your specific requirements. Specify body material when ordering.

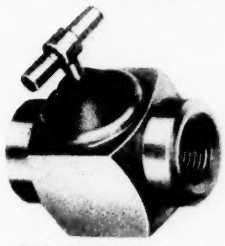
Write us for complete technical information, or for the address of our representative in your area.

AM-1 Packless Angle Valve, (¼" male — ¼" female NPT).

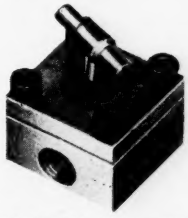
REPRESENTATIVES IN PRINCIPAL CITIES

GEORGE W. DAHL COMPANY, INC.

86 TUPELO STREET, BRISTOL, R. I.



G-8 Packless Globe Valve with standard internal ports. (Inlet and outlet ports, ½" NPT).



AT-1 Packless Globe Valve, all wetted parts TEFLON, in stainless steel housing with bolted bonnet, (¼" NPT).

G-9 Packless Globe Valve with panel-mount bonnet and extension stem equipped with anodized aluminum handle.

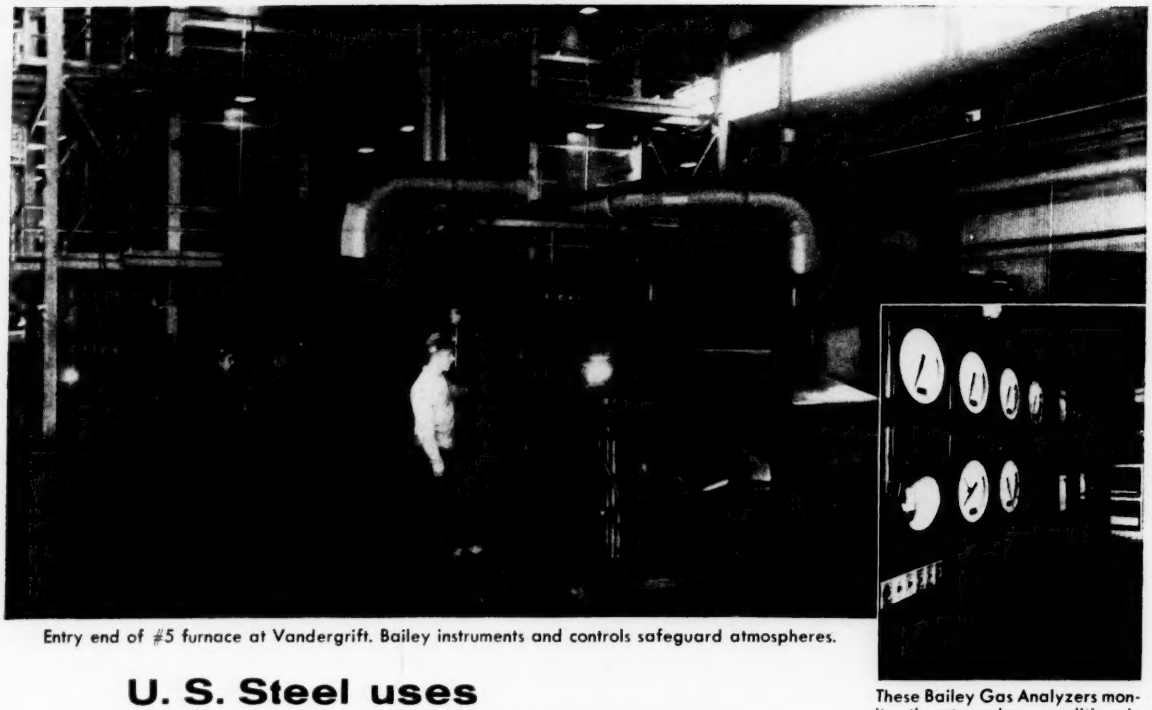
AR-16 Air Rate Indicator, range 0-2 SCFH. Unit is complete with toggle actuated packless valve, anodized aluminum bodies and protective column studs. (Other ranges available.)

AR-17 Air Rate Indicator similar to AR-16, but with needle valve for minute adjustment, ideal for purge meter application.

13-2 3-Way Valve designed for shuttling, blending or selecting. Stainless steel diaphragm, TEFLON seats, panel-mount bonnet and anodized aluminum handle, (¼" NPT).

For more information circle **27** on inquiry card.

HOW TO CONTROL ATMOSPHERES...



Entry end of #5 furnace at Vandergrift. Bailey instruments and controls safeguard atmospheres.

These Bailey Gas Analyzers monitor the atmosphere conditions in heating and cooling zones in the furnaces.

U. S. Steel uses BAILEY GAS ANALYZERS on continuous annealing line

At its Vandergrift, Pa., plant, U. S. Steel Corporation runs five lines for the continuous annealing of silicon strip steel used in making transformer and motor laminations. The furnaces are composed of a heating and cooling zone, each with its own protective atmosphere. Bailey Gas Analyzers are used to indicate that proper atmospheres are maintained for the protection of the product.

In starting up, furnaces must be thoroughly purged of all oxygen to prevent explosions. Bailey Oxygen Recorders determine completeness of purge before hazardous protective gas may be used. Bailey Combustibles Recorders are also used during purging as a check on the Oxygen Recorders. After purging, they analyze the incoming NX gas.

When operating, the furnaces are provided with the proper protective atmosphere composed of NX gas and dissociated ammonia. Bailey Hydrogen Recorders keep constant watch on the per cent hydrogen in the mixture. Bailey NX Gas and Dissociated Ammonia Flow Meters are used in regulating the total flow and composition of protective atmospheres.

As an additional safeguard, Bailey Furnace Pressure Recorders are used. These instruments control the protective gas flow to eliminate air infiltration into the furnaces.

Since 1948, when this Bailey equipment was installed, a perfect safety record has been maintained, yet purge time has been substantially reduced. Formerly purging was done on a time basis which was wasteful of gas and time. Steel quality has been uniformly high and high production has been maintained with the Bailey controls.

Whether your heat treating requires several huge continuous lines like these or one small batch-type furnace, Bailey Meter has the instruments and controls for you. See your Bailey Engineer or write to the Iron & Steel Division for additional information.

S11-1

BAILEY METER COMPANY

IRON AND STEEL DIV., 1041 IVANHOE ROAD, CLEVELAND 10, OHIO

In Canada — Bailey Meter Company Limited, Montreal

INSTRUMENTS AND CONTROLS FOR POWER AND PROCESS

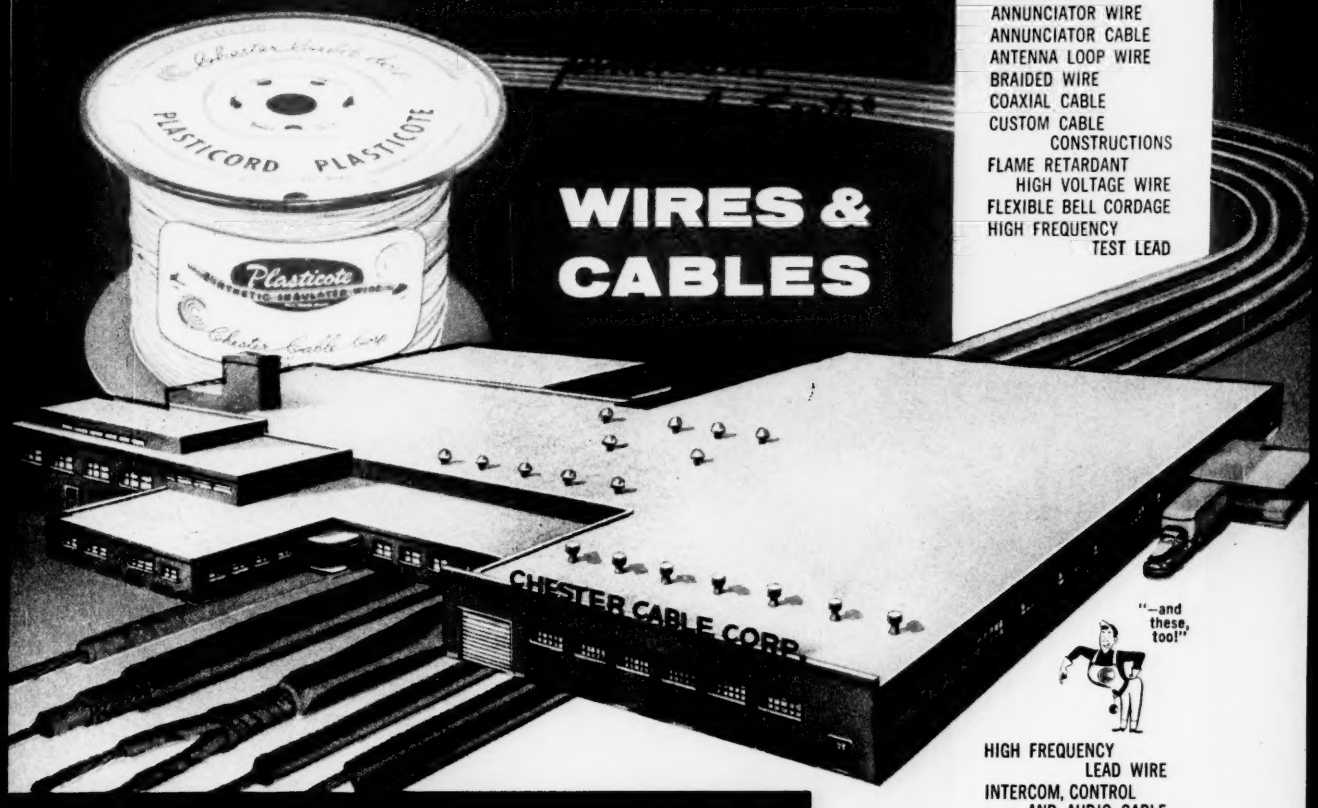
BAILEY METERS

BAILEY BUILDING BLOCK METHOD

For more information circle **28** on inquiry card.

CHESTER

WIRES & CABLES



...gress...

A complete line of quality wires and cables including—

AIRSAC TV LEAD-IN WIRE
APPLIANCE WIRE
ANNUNCIATOR WIRE
ANNUNCIATOR CABLE
ANTENNA LOOP WIRE
BRAIDED WIRE
COAXIAL CABLE
CUSTOM CABLE CONSTRUCTIONS
FLAME RETARDANT HIGH VOLTAGE WIRE
FLEXIBLE BELL CORDAGE
HIGH FREQUENCY TEST LEAD

HIGH FREQUENCY LEAD WIRE
INTERCOM, CONTROL AND AUDIO CABLE
MICROPHONE CABLE
MIL HOOK-UP WIRE
MINIATURE WIRE AND CABLE
MULTIPLE CONDUCTOR CABLE
NYLON COATED WIRE
OVERBRAIDS
"PARALLEAD" TV LEAD-IN WIRES
PHONOGRAPH PICK-UP CABLE
PHOTOELECTRIC CELL CABLE
ROTOR CABLE
RVC-300 APPARATUS WIRE
SHIELDED CABLE
TEFLON® LEAD WIRE
TELEPHONE BRIDLE WIRE
TELEPHONE CABLE
TELEPHONE INSIDE WIRE

Expanded plant facilities assure fast service on famous-for-quality Chester wires and cables

The new ultra-modern Chester Cable Corporation plant is now in full production on super-rugged extra-pliable Plasticote and Plasticord wires and cables. These longer-lasting Chester conductors, plus nylon coated and teflon wrapped wires are available in standard types to meet every wiring requirement. When specifications indicate the use of custom constructions, they can be produced to your special design. The Chester engineering staff, and research facilities, are available to help solve unusual wiring problems.

Pioneer Producers of Plastic Insulated Wires and Cables since 1940

CHESTER CABLE CORP.

A Subsidiary of Miami Copper Company

5 HILL STREET, CHESTER, N. Y.

For more information circle **29** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters
INLET PORT
DISCHARGE PORT
DISCHARGE PORT
INLET PORT
ROTATION IS CLOCKWISE

Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.

No dust filters.

No internal lubrication to contaminate air handled.

No internal wearing parts.

No valves, pistons, or vanes.

Non-pulsating pressure.

Original performance constant over a long pump life.

Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

Circle 30 on inquiry card.

PARTLOW MFS CONTROL
New visibility and functional good looks in a control engineered for utmost precision even under extreme conditions.

NEW FROM PARTLOW

An Industrial Temperature Control designed with the Look of Tomorrow

by RAYMOND LOEWY Associates

NEW FROM PARTLOW

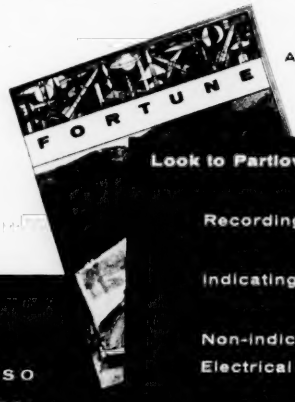
A Temperature Control Created to Improve the Efficiency . . . and Appearance . . . of Any Process Equipment You Use or Manufacture

You can tell at a glance that the new Partlow MFS is like no control you've ever seen before. Created by famed Raymond Loewy Associates, it clearly marks a new high in modern good looks as applied to control design. But even more important is what lies 'under the hood'... a high-precision, mercury-actuated mechanism built to give you a lifetime of ultra-accurate and trouble-free performance.

If your products or processes require sure, precise measurement and control of temperature within the −30° F. to 1100° F. range, it will pay you to investigate now the wide variety of rugged, accurate Partlow controls for every purpose. A Partlow staff engineer is available for consultation on any application problem.

WRITE TODAY:

THE PARTLOW CORP.
DEPT. IA-258
NEW HARTFORD, N.Y.



As advertised in Fortune

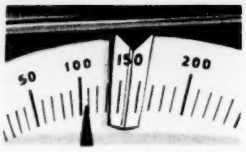
Look to Partlow when you need:

- Recording Controls
- Indicating Controls
- Non-indicating Electrical Controls
- Non-indicating Mechanical Controls
- Limit Controls
- Recording and Indicating Thermometers
- Combustion Safeguards
- Timers

PARTLOW

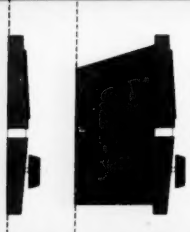
Pioneer in Mercury-Actuated Temperature Controls

NOW, ONLY IN THE NEW PARTLOW MFS CONTROL, SO MANY ULTRA-NEW AND ULTRA-PRACTICAL FEATURES:



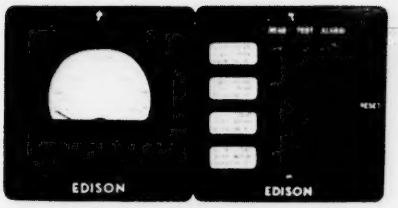
Pointer magnification with parallax sighting for closest possible settings!

Dial calibrations, background and pointers color-contrasted for maximum readability—even at a distance.



Flush or Wall mounting, with no additional brackets or hardware required.

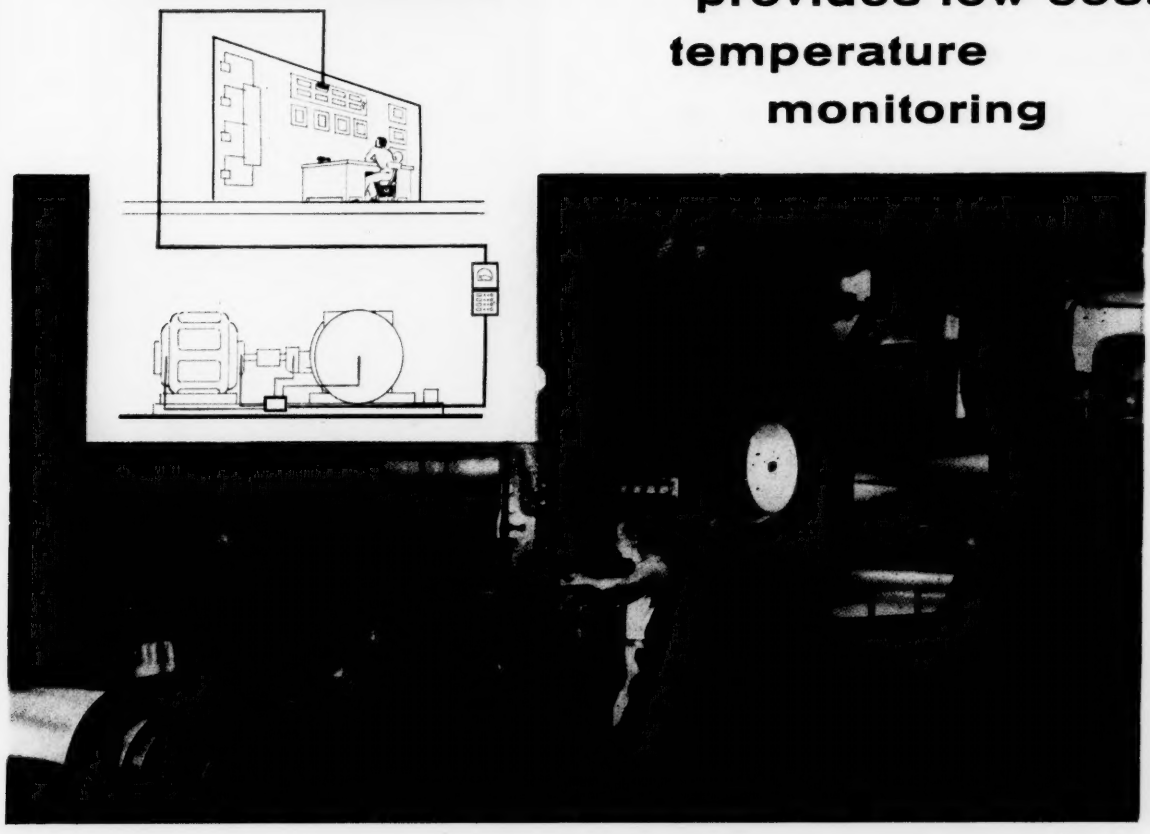
Reinforced polyester plastic in a smooth semi-gloss gray finish . . . strong, lightweight, easy to clean . . . won't rust, won't crack under extreme temperatures.



THOMAS A.

EDISON

omniguard system provides low cost temperature monitoring



Edison Omniguard is the simplest and most flexible monitoring system devised for protection against excessive bearing temperatures, gases and liquids. In an Omniguard installation, plug-in monitor units are grouped according to individual requirements—can be added, removed or switched to other equipment without disturbing the system. Individual alarm settings on each point can be changed at any time without special tools.

This kind of flexibility pays off in reducing installation costs by 50% or more . . . permits purchase of minimum number of units needed at any one time . . . and the addition of more points as new equipment is installed.

Other exclusive Omniguard advantages: Single indicator serves multiple points • each circuit is 'on guard' at all times • no moving parts, nothing to wear out • alarm positively identifies trouble point.

Edison Resistance Temperature Detectors coupled with automatic monitors are low cost insurance against loss of production time, equipment replacement and costly repair charges.

Typical Omniguard Panel shows group of monitor units with their alarm lights, test buttons, and temperature read-out switches. Additional units can be installed in a variety of ways to suit your individual needs.

For additional information on the Edison Omniguard, write for Bulletin 3036B.

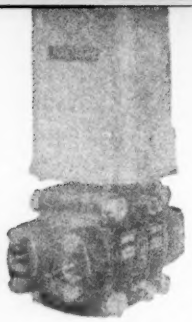
Thomas A. Edison Industries

INSTRUMENT DIVISION

24 LAKESIDE AVENUE, WEST ORANGE, N. J.

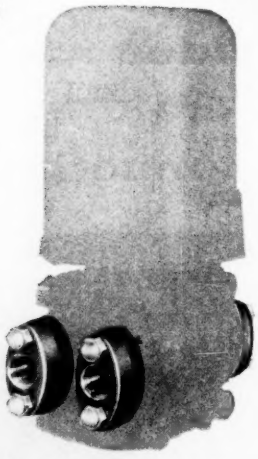
For more information circle **31** on inquiry card.

←——Circle **30** on inquiry card.

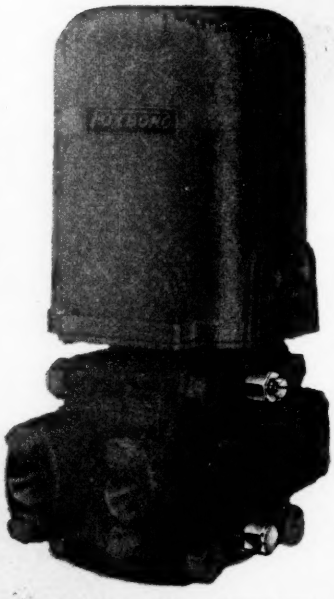


FOXBORO d/p CELL

unequaled –



Simplest installation — orifice flange tap connections at standard spacing, are provided at both ends.



Drain and vent holes at lowest and highest points on both sides.

Purged cover protects transmitter from weather, dust, and fumes.

Over 60,000 now in use!

No zero drift . . . positive overrange protection . . . high sustained accuracy even under the most punishing operating conditions. No wonder over 60,000 Foxboro d/p Cell Transmitters have been installed since they were introduced in 1948.

By introducing the modern concept of high speed flow measurement and control, these differential pressure transmitters have *revolutionized* many an industrial process. Bulletin 13-11A shows how — and portrays the benefits the d/p Cell Transmitter offers you. Write **The Foxboro Company, 462 Norfolk St., Foxboro, Mass., U.S.A.**

FOXBORO

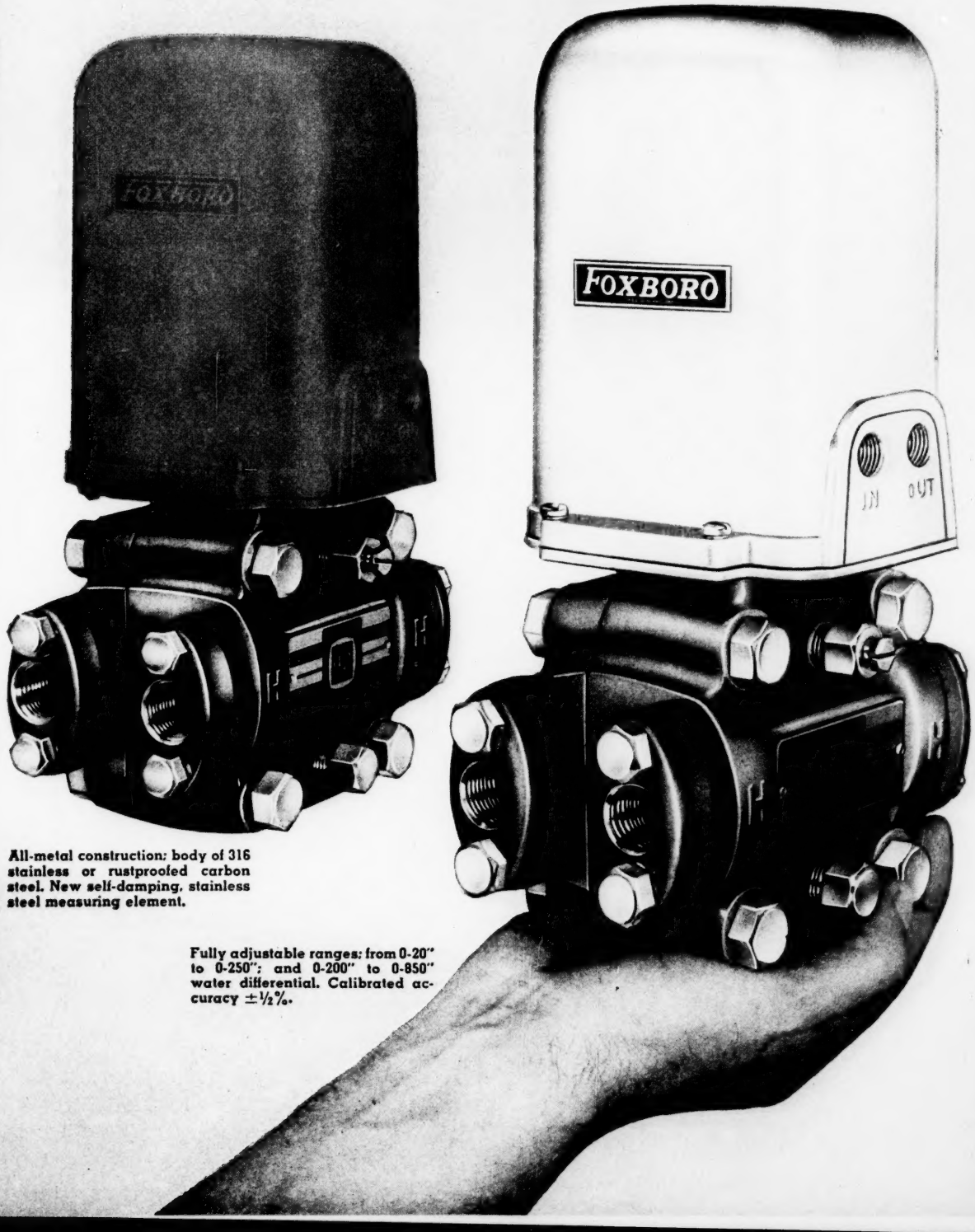
REG. U.S. PAT. OFF.

FIRST in Flow Measurement and Control

For more information circle **32** on inquiry card.

FLOW TRANSMITTERS...

in accuracy, stability and performance



All-metal construction: body of 316 stainless or rustproofed carbon steel. New self-damping, stainless steel measuring element.

Fully adjustable ranges: from 0-20" to 0-250"; and 0-200" to 0-850" water differential. Calibrated accuracy ±½%.

THE AMERICAN PLATINUM WORKS
NEWARK, NEW JERSEY

AMERSIL CO., INC.
HILLSIDE, NEW JERSEY

BAKER & CO., INC.
NEWARK, NEW JERSEY

EAST NEWARK INDUSTRIAL CENTER, INC.
EAST NEWARK, NEW JERSEY

HANOVIA CHEMICAL & MANUFACTURING CO.
NEWARK, NEW JERSEY

IRVINGTON SMELTING & REFINING WORKS
IRVINGTON, NEW JERSEY

D. E. MAKEPEACE COMPANY
ATTLEBORO, MASSACHUSETTS

NATIONAL ELECTRIC INSTRUMENT CO.
ELMHURST, NEW YORK

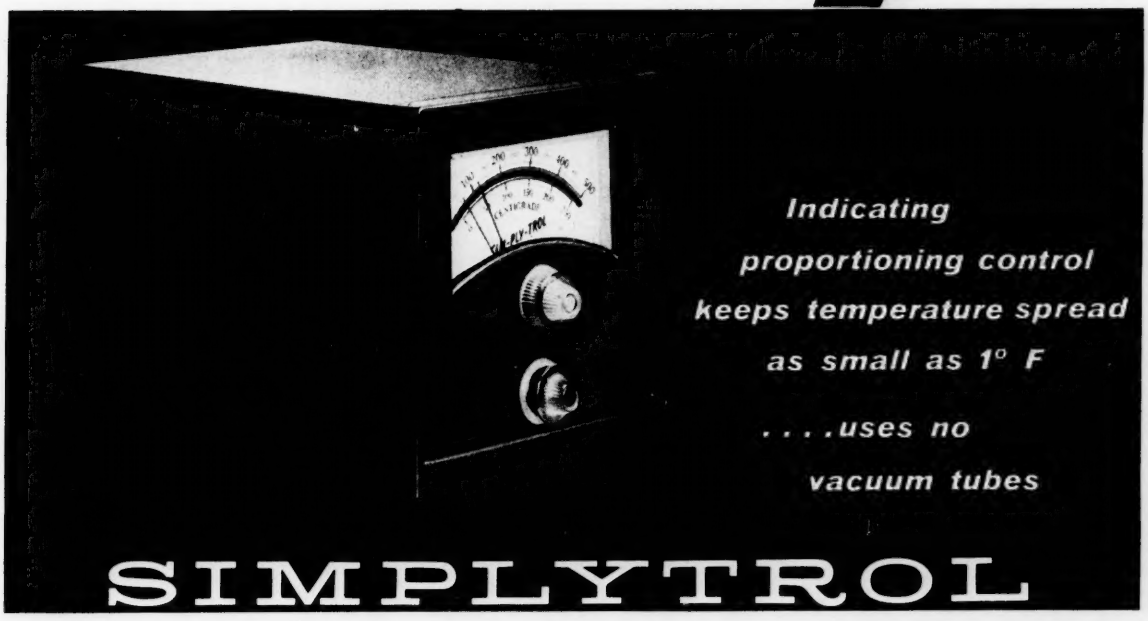
THE H. A. WILSON COMPANY
UNION, NEW JERSEY

ENGELHARD INDUSTRIES ANNOUNCE THE CONSOLIDATION OF THE DOMESTIC AFFILIATED COMPANIES LISTED ABOVE UNDER A UNIFIED CORPORATE MANAGEMENT. THEY WILL HENCEFORTH BE DESIGNATED AS DIVISIONS OF ENGELHARD INDUSTRIES, INC.

ENGELHARD INDUSTRIES OF CANADA, LTD., TORONTO, ENGELHARD INDUSTRIES OF QUEBEC, LTD., MONTREAL, ENGELHARD INDUSTRIES, LTD., LONDON, ENGELHARD INDUSTRIEN A.G., ZURICH, GLOVER & GOODE PTY., LTD., MELBOURNE, GLOVER & GOODE BASE METALS PTY., LTD., MELBOURNE, SOCIEDAD SURAMERICANA DE METALES PRECIOSOS S.A., BOGOTA, INDUSTRIE ENGELHARD S.P.A., ROME, THE DEVELOPMENT AND INVESTMENT COMPANY OF SOUTH AFRICA, LTD., JOHANNESBURG, AZOPLATE CORPORATION CHARLES ENGELHARD, INC., NUCLEAR CORPORATION OF AMERICA, INC., SOUTH AFRICAN FOREST INVESTMENTS, LTD., ACME TIMBER INDUSTRIES, LTD.

a new api meter-relay temperature controller that...

ANTICIPATES



SIMPLYTROL

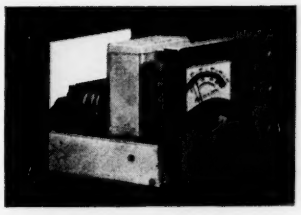
This Simplytrol time-proportioning control anticipates temperature overshoot, and shuts off heat in time to prevent it.

As the contact on the indicating pointer of the Simplytrol meter-relay moves close to the contact on the set pointer, an anticipating circuit permits electrostatic attraction between the contacts to build up.

The result is extreme sensitivity close to the set point, since any change in temperature there is greatly magnified. A very small rise shuts heat down; a slight decrease gives a longer duty (heat on) cycle.

Controls are thermocouple-actuated and give continuous indication without the distortion sometimes found in non-absolute systems. 21 ranges covering temperatures from −400° to +3000°F. List prices from $147 to $165.

Ask for Data Sheet No. 9.



Equally suitable for panel mounting or table use, the new Model 200 housing is 6½" x 6½" x 10" approx.

Assembly Products Inc.

75 Wilson Mills Road, Chesterland 10, Ohio • Phone (Cleveland) HAmilton 3-4436

Specify api *meter relays with* LOCKING CONTACTS *for dependability*

See us at the Atom Fair, International Amphitheatre, Chicago, March 17-21

For more information circle **34** on inquiry card.

←Circle **33** on inquiry card.

briefs

53,000 Connectors

The intent of this plug guide is to provide an orientation guide to the more than 53,000 different items manufactured by Cannon Electric Co. The pages following show representative connectors from each series group, and attempt to show the relationships between the groups.

SERIES	MS AN	MS RELATED	K
PAGE	14-15	16-17	18-19
high temperature firewall	•	•	•
hermetically sealed		•	•
moisture proof	•	•	
water proof		•	
vibration proof	•	•	
pressurized	•		•
audio			•
video			•

In the table below, the recommended current ratings are listed for the various contact sizes. The contacts are referred to in American Wire Gage standard sizes.

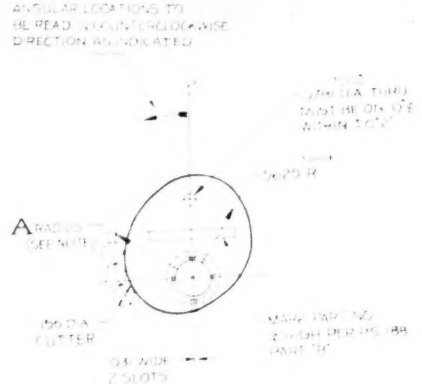
Amperage	Contact Size same as Wire Gage	Amperage	Contact Size same as Wire Gage
200	#1 0	40	# 8
115	#2	30	#10
80	#4	15	#14
60	#6	10	#16

Cannon connectors are also available with current ratings greater than 200 amperes, particularly in the battery connector line. These high power connectors run from 250 to 1500 amperes, although the latter size is presently limited to one connector.—*(From new 44-page Catalog CPG-3, Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.)*

For this literature circle **201** on inquiry card.

Computer Designs Cams

Time savings of 150:1 have been realized in design of complex cams for the Eclipse-Pioneer Air Data Computer . . . . by the Bendix G-15 General Purpose Computer. 1400 radii are computed for cams the size of a 50 cent

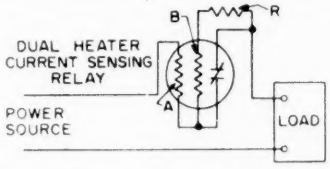


piece, with accuracy to the nearest 0.0001" . . . On one project alone, hundreds of thousands of equations that would take an engineer 3 years to calculate, and possibly a 4th to check, were solved in 40 hours. *(From new 4-page Application Report III 087, Bendix Computer, Div. of Bendix Aviation Corp., 5630 Arbor Vitae St., Los Angeles 45, Calif.)*

For this literature circle **202** on inquiry card.

Electro-Magnetic Relays

The major field of application for thermal relays has been time delay. Here advantage is taken of the fact that time is required for the energizing current to produce the necessary temperature rise for contact operation . . . . The other major field of application for thermal relays



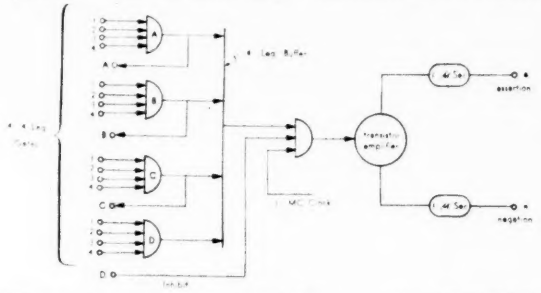
is their use as voltage or current sensing elements primarily for the protection of circuits or equipment . . . Other applications which have been made in the last few years . . . include a thermal overload relay with a double heater construction, incorporating a lock-out feature (illustration).

In this circuit, with the normal load the current through winding A leaves the contacts unoperated. Upon over-load the contacts open, thus inserting in series the higher resistance winding B. Both windings affect the same thermal element, so enough heat is produced to hold the contacts open. Further, the higher resistance of winding B, aided by resistor R, limits the load current until the circuit malfunction can be corrected . . .—*(From new 136-page reprint of papers given at Fifth Symposium on Electromagnetic Relays at Oklahoma State University, Potter & Brumfield, Inc., Princeton, Ind.)*

For this literature circle **203** on inquiry card.

Digital Modules

The design of the T-PAC family of digital modules is based upon the use of dynamic circuitry techniques first developed and applied to digital systems by the National Bureau of Standards within the last decade . . . For the reader who may be unfamiliar with the concepts of dynamic circuits, following are listed some of the significant features of this relatively new technique . . . (1) The dynamic circuit amplifier that is contained in the Logical

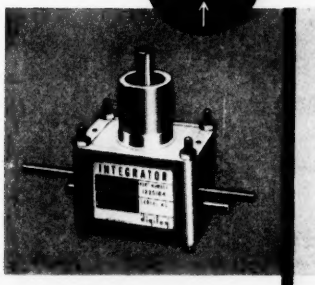


Element is a true pulse amplifier . . . (2) All T-PACs are synchronously operated with respect to the basic one-megacycle clock frequency . . . (3) By means of high fidelity electrical delay lines mounted within the Logical Element both positive and negative outputs occur precisely one microsecond delayed from the input which generated them, and in synchronization with the clock output. (4) The diode gating configuration, or "decision-making" element, is internal to the Logical Element module and constitutes the input part of the circuit . . . *(From new 16-page Catalog T, Computer Control Co., Inc., 92 Broad St., Wellesley 57, Mass.)*

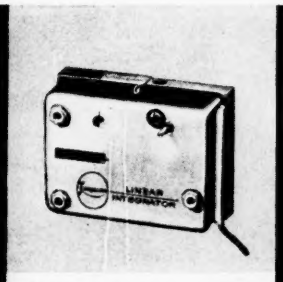
For this literature circle **204** on inquiry card.

Computing Components/ Instrumentation and Controls

BY LIBRASCOPE

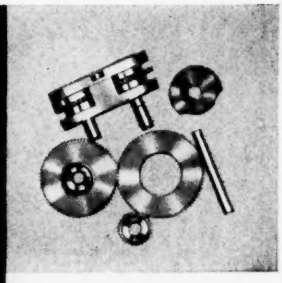


Ball-Disc Integrator... for use in totalizing, rate determination, differential analyzers, or as a closed loop servo-element... 0.01%V(av) optimum reproducibility.



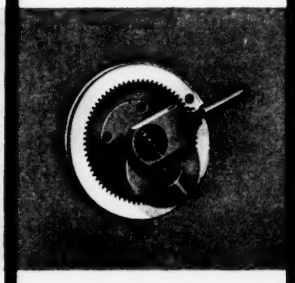
Linear Integrator... for systems or instruments requiring integration, averaging computations, direct or remote reading... mounted on chart recorder.

Flow Computer... extracts square root and continuously integrates both differential and static pressures for applications such as orifice measurement of fluids.

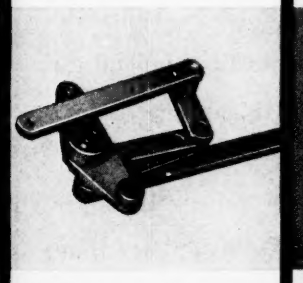


Custom Gears; Limit Stops, Shafts, Coupling and Cams... for computer, servomechanisms and instrument applications.

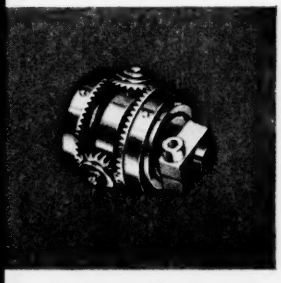
Analog Digital Converters... for converting shaft position to digital information available in Binary, Gray code or Binary decimal. Also Sine Cosine functions.



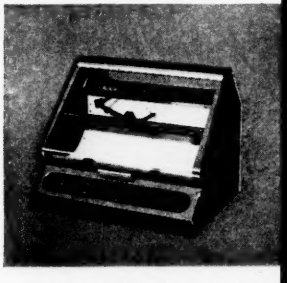
Sine Cosine Mechanism... for problems of changing variables involving vector components, range and bearing computations, sight computation, etc.



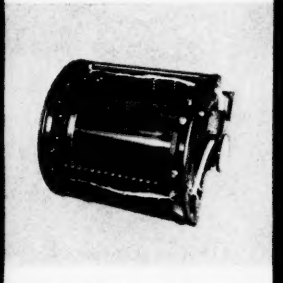
Linkages... for computing equipment; precision addition, subtraction linkages; multiplying linkages and function generators with displacement outputs.



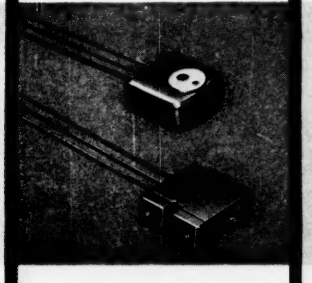
Hollow Shaft Differential... offers greater versatility in summing angular shaft positions; Hollow Shaft reduces breadboard and production costs.



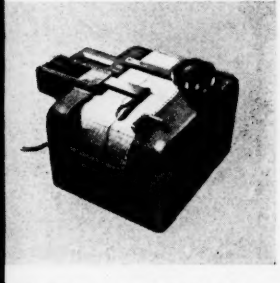
X-Y Plotter and Recorder... for point or continuous plotting, with positive mechanical drive in recording graphic data. Several models and accessories available.



Magnetic Storage Drum... for medium storage applications; capacity 131, 072 non-volatile bits; drum speed 3800 rpm; clock frequency 130 kc.



Read-Record Heads... for high frequency, non-contact recording applications in magnetic memory systems; high read back signals.



Planimeters... for miniature strip chart recorders for simple integration with variable speed control; 2 models: square root and linear.

There are available catalog sheets, bulletins or folders on all our products.

RELIABILITY is the prime consideration in the design and construction of the extensive line of Librascope products—the result of 20 years in the successful manufacture of mechanical, magnetic, optical, electronic and electrial instruments for military, research and commercial uses.

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For more information circle **35** on inquiry card.

NO matter how perfect otherwise, the human organism isn't much good without a dependable heart. The same is true of your automatic temperature and pH control instruments.

The "heart" of most such instruments for the past quarter century has been the Eplab Standard Cell. It is a "yardstick" for translation of voltage to temperature or pH. The first American commercial cell of its type, constantly improved by research, it is "as standard as sterling".

Get ACCURATE temperature or pH control with potentiometers and make sure the standard cells are EPLAB.

The Eppley Laboratory, Inc. 2 Sheffield Ave., Newport, R. I.

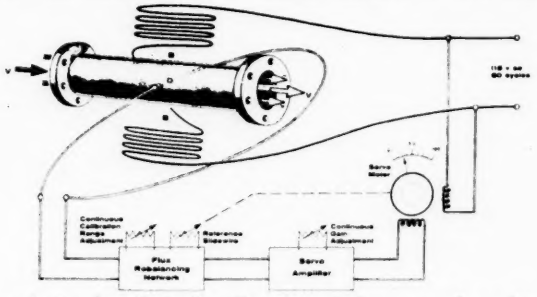
EPLAB *Standard* CELLS
FOR POTENTIOMETRIC INSTRUMENTS
"As Standard as Sterling"

For more information circle **36** on inquiry card.

BRIEFS—CONTINUED

Magnetic Flowmeter

The voltage (E) induced in a conductor (the metered fluid) of length (D) that is moving at right angles through a magnetic field (B) is directly proportional to the fluid velocity (V)—provided that the field strength and the conductor length remain constant. In this case



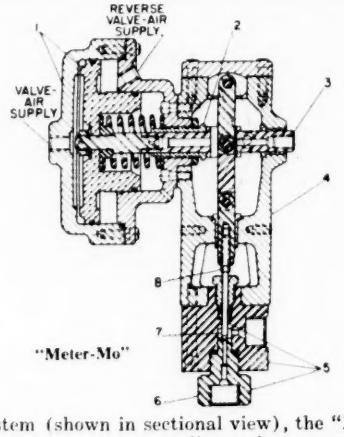
conductor length is the diameter of the measuring pipe and therefore does not change.

In the F&P Magnetic Flowmeter, the field is supplied by an electromagnet with specially designed cells which produce a uniform field, insuring that Q (volumetric rate of flow) = KE, regardless of velocity profile. (*From new 4-page Catalog* 10*D*1416, *Fischer & Porter Co., 775 Warminster Rd., Hatboro, Penna.*)

For this literature circle **205** on inquiry card.

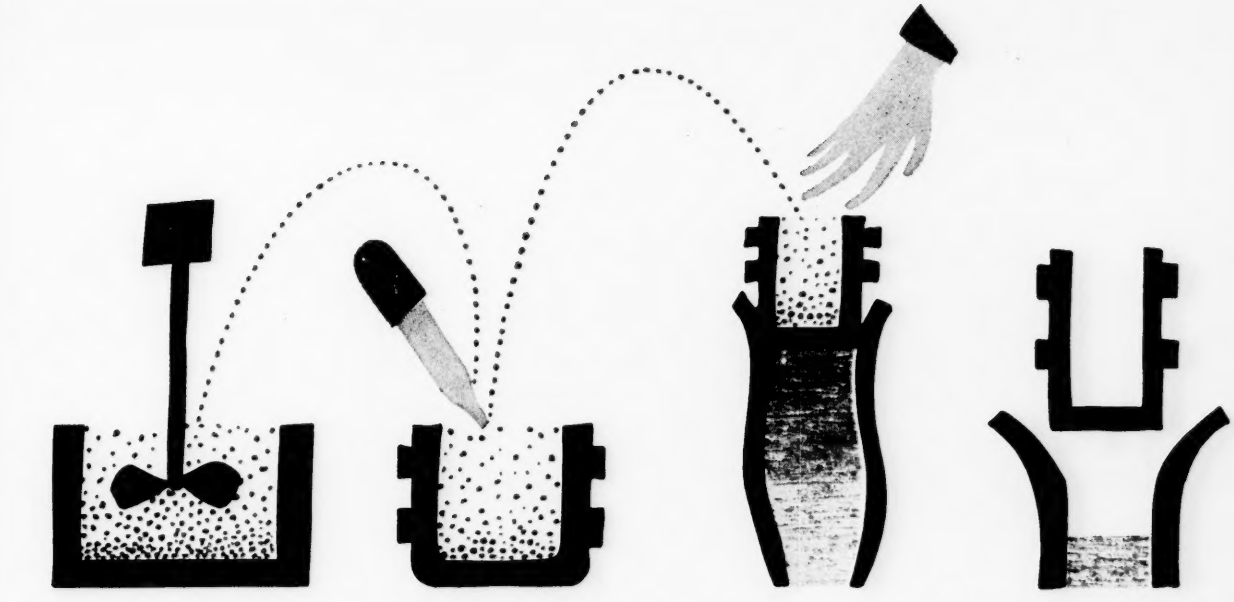
60,000-PSI Proportioning Valves

The "Meter-Mo" is a pneumatic piston-type valve operated by 30-p.s.i. air. A power valve-positioner provides positive control of valve position. The short stroke and unique linkage give a full-open to full-closed operating time of only one-tenth second. By employment of this

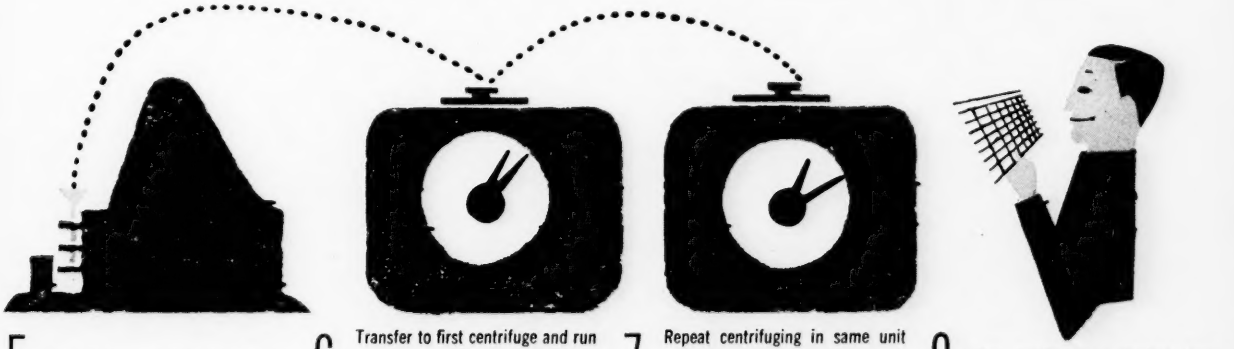


linkage system (shown in sectional view), the "Meter-Mo" valve is able to translate a linear instrument air impulse into a motion of the valve stem, resulting in nearly elliptical flow characteristics at low flow rates on the high-pressure side of the valve . . . Pressure rating—Available in two ranges: from zero to 10,000 p.s.i. and from zero to 60,000 p.s.i. Types of Operators—1. Power valve-positioner (standard equipment). 2. Pneumatic reversing relay in addition to the power valve positioner (available at extra cost). Rangeability—C_v values between 0.000001 and 0.18 can be varied and follow a smooth (nearly parabolic) curve.—(*From new* 125-*page Catalog* 407, *American Instrument Co., Inc.*, 8030 *Georgia Ave., Silver Spring, Md.*)

For this literature circle **206** on inquiry card.



1. Prepare suspension of particles.
2. Transfer suspension to feeding chamber.
3. Transfer feeding chamber to centrifuge tube.
4. Remove feeding chamber, leaving sharp layer of suspension on top of sedimentation liquid.



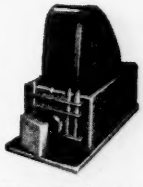
5. Read sediment height under gravity in projector at precalculated times.
6. Transfer to first centrifuge and run for precalculated time, then remove and read in projector.
7. Repeat centrifuging in same unit or in higher speed centrifuges until run is complete.
8. Size distribution is obtained from sediment height data.

New Low-Cost Way to Measure Size Distribution of Small Particles

With the new M-S-A® Particle Size Analyzer, you can start with a minimum investment for measuring particle distribution, and then expand it by the purchase of additional components.

This versatile analyzer is a general-purpose device for measuring size distribution of small particles. It is especially designed for measurement of subsieve particles between approximately 0.1 and 40 microns. Most airborne dusts, paint pigments, and many flours, chemicals, and pharmaceuticals lie within this range.

Complete analyzer system includes centrifuge tubes, feeding chamber, optical tube projector, one or more special centrifuges, and tube handling and cleaning accessories. Write for new bulletin for details.



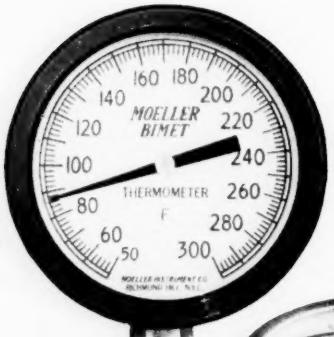
Tube Projector

Centrifuges

MSA

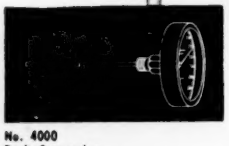
INSTRUMENT DIVISION
Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania

For more information circle **37** on inquiry card.



No. 4500
Straight Connection
5" Diameter Brass Case
in Black Finish

No. 4250
Angle Form Connection
3" Diameter Stainless
Steel Case



No. 4000
Back Connection
5" Diameter Brass Case
in Black Finish

You get dependability PLUS in Moeller Bimet Dial

thermometers

because—the design and manufacture of temperature measuring instruments has been our business since 1867.

The sturdy construction, coupled with easy-to-read dials assure continued top performance in accuracy and reliability.

Specify and install Moeller Bimets . . . built upon 90 years of experience. For information mail the coupon, today.

MOELLER INSTRUMENT COMPANY 132nd ST. and 89th AVE. RICHMOND HILL 18, N. Y.

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Gentlemen: Without obligation, please send me the new Moeller Bimet Thermometer Catalog No. 225C.

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FIRM .....

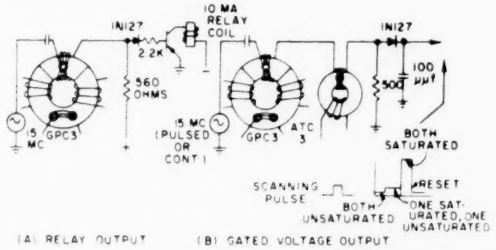
ADDRESS .....

CITY ..... ZONE ..... STATE .....

For more information circle **38** on inquiry card.

Magnistor

The Magnistor, a new circuit element, is a small saturable reactor with a ferro-ceramic core having a speed of response approaching that of a vacuum tube. It permits the use of saturable reactor and magnetic amplifier circuits in high frequency applications. There are two basic



Magnistors, the Transient type and the Permanent type . . . Transient Magnistors may be used as gates and power amplifiers . . . Permanent Magnistors may be used as flip-flop memory gates . . . The core is a high retentivity, "square loop" ferrite ring from which a wedge shape piece has been removed. Inserted in place of the wedge is a piece of soft ferrite to complete the loop. The signal winding is wound on the soft core insert. A reset coil is wound through two holes in the hard core and two set coils are wound around the hard core ring. The set coils when pulsed with a current of either polarity and proper amplitude will establish sufficient flux in the hard core material to saturate the soft core of the signal winding . . . *(From new 12-page bulletin, Mag-Tran Sales Corp., 210 S. Broad St., Ridgewood, N. J.)*

For this literature circle **207** on inquiry card.

Model MFS

The Partlow MFS control . . . can be supplied in either of two fixed sensitivities: (1) normal, one percent of scale range, or (2) close, one-half percent of scale range . . . Although the Model MFS is designed primarily for the control of heating processes, it can also be used to control cooling processes (by specifying normally-open snap-acting switches in place of the customary normally-closed). In such cases the instrument regulates the flow of a coolant (such as water) or starts and stops refrigerating compressors.

TABLE 3

TO SPECIFY INSTRUMENT

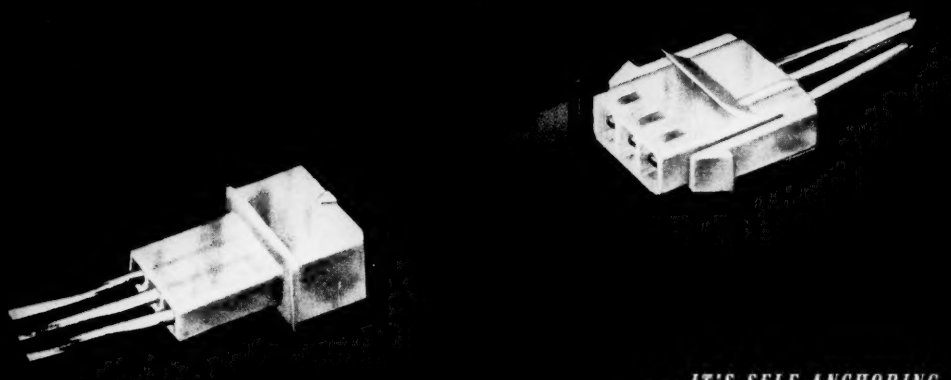
INSTRUMENT DESIGNATION	CONTROL CIRCUIT 2-WIRE Normally Open	2-WIRE Normally Closed	3-WIRE Double Throw	INSTRUMENT CAPACITY	GENERAL APPLICATION
MF2		•			process heating
MF3	•			500 volt-amps	cooling or refrigeration
MF4			•	non-inductive	3-wire applications
MF5		•		loads (50	process heating
MF6	•			volt-amps	cooling or refrigeration
MF7			•	inductive load)	3-wire applications

Table 3 shows the 6 most-used variations of the Model MFS, for various classes of service. Other variations are occasionally employed. For example, wide-variation switches may be used for applications in which it is not desirable for the control to operate unless temperatures drift beyond rather broad limits, and manual reset switches may be used for limit control (rather than thermostatic control) purposes.—*(From new 4-page Bulletin 320, The Partlow Corp., New Hartford, N. Y.)*

For this literature circle **208** on inquiry card.

AMP-lok

the new concept in multiple connector design



. . . IT'S SELF-ANCHORING

AMP

AMP-lok **eliminates the necessity for supplementary mounting devices in through panel multiple connector applications.**

Additional literature and samples available on request.

AMP-lok obsoletes all it replaces because of the following design features:

- contacts are identical . . . self-cleaning recessed for safety
- finger grip engagement and disengagement
- polarized to eliminate circuit error
- wide panel thickness accommodation – one simple mounting hole required
- color-coding available

AMP-lok **can be used as a safe, free-hanging multiple connector, also.**

AMP INCORPORATED

GENERAL OFFICES:

3739 Eisenhower Blvd., Harrisburg, Pa.

Wholly Owned Subsidiaries: Aircraft-Marine Products of Canada Ltd., Toronto, Canada • Aircraft-Marine Products (Great Britain) Ltd., London, England • Societe AMP de France, Le Pre St. Gervais, Seine, France • AMP – Holland N. V. 's-Hertogenbosch, Holland Distributor in Japan: Oriental Terminal Products Co., Ltd., Tokyo, Japan

For more information circle **39** on inquiry card.

MISSILE QUALITY AC DRIVE MOTORS

Oster®

Complete Line / *Gear Trains Available with Many Types*

Meet MIL-E-5272A / Dimensions from 15/16" to 2-3/8".

SIZE	VOLTAGE	FREQ. C.P.S.	NO. PHASES (SUPPLY)	NO LOAD SPEED (RPM)	CAPACITOR (MFD)	RUNNING CURRENT AMPERES	RUNNING WATTS INPUT	OUTPUT	WEIGHT	GEAR RATIO	TYPE NUMBER
10	115	400	1	10,000	.05	.035	4.0	0.112 oz. in. at 6000 rpm	2.0 Oz.	....	10 A 8104 02
10	115	400	1	11,000	None (Shaded Pole)	.085	7.5	.096 oz. in. at 7000 rpm	3.5 Oz.	....	10 A 8101 01
11	115	400	1	12,000 Synch	0.1	.070	8.0	.08 oz. in. at 12,000 rpm	4.0 Oz.	....	11 A 8110 01
11	115	300 1800	1	10,000 (400 CPS)	0.5 (In Parallel)	.060 (400 CPS)	8.0 (400 CPS)	0.10 oz. in. at 9000 rpm (400 CPS)	5.0 Oz.	....	11 A 8223 01
11	115	400	1	60 Synch	0.1	.070	8.0	12 oz. in. at 60 rpm	7.75 Oz.	200:1	11 R 9003 02
11	26	400	1	30 Synch	2.0	0.35	8.0	14.5 oz. in. at 30 rpm	5.5 Oz.	195:1	11 R 9052 01
15	115	400	1	6,000 Synch	0.3	0.138	15.6	0.14 oz. in. at 6,000 rpm	8 Oz.	....	15 A 8120 01
18	115	400	1	12,000 Synch	0.35	0.148	14.7	0.41 oz. in. at 12,000 rpm	8 Oz.	....	18 A 8125 01
18	115	400	1	7600	0.6	0.45	4.5	2.45 oz. in. at 6800 rpm	24 Oz.	....	18 A 8126 01
18	115	60	1	8.5	1.0	0.175	17.5	30 oz. in. at 8 rpm	20 Oz.	405:1	18 R 9302 01
18	115	60	1	6.0	1.0	0.177	17.8	40 oz. in. at 5.75 rpm	20 Oz.	565:1	18 R 9302 02
21	115	400	1	22,000	1.0	0.75	80.0	1 oz. in. at 20,000 rpm	18.5 Oz.	....	21 A 8142 01
24	115	400	1	11,800	1.5	0.85	130.0	6.17 oz. in. at 10,800 rpm	29 Oz.	....	24 A 8161 01
24	115	60	1	20,000	None Required	1.2	175	8.9 oz. in. at 7,500 rpm	28 Oz.	....	24 U 8826 02
24	115	400	1	78	4.0	1.65	175	1530 oz. in. at 72 rpm	3 Lbs.	1528:1	24 R 9452 02
34	115	60	1	14,000	None Required	1.5	125	15 oz. in. at 4500 rpm	3-3/4 Lbs.	....	34 U 8901 02
34	115	60	1	1,780	3.75	0.45	50	12 oz. in. at 1700 rpm	4-3/4 Lbs.	....	34 A 8044 01

- All motors are continuous duty except Type 24-U-8826-02.
- −55° C to +85° C operating temperature range.
- All motors can be modified to meet your precise specification.
- For faster service, detail requirements when requesting further information.

Other products include servos, synchros, motor-gear-trains, resolvers, DC motors, servo mechanism assemblies, servo torque units, motor tachs, reference and tachometer generators, actuators and motor driven blower and fan assemblies.

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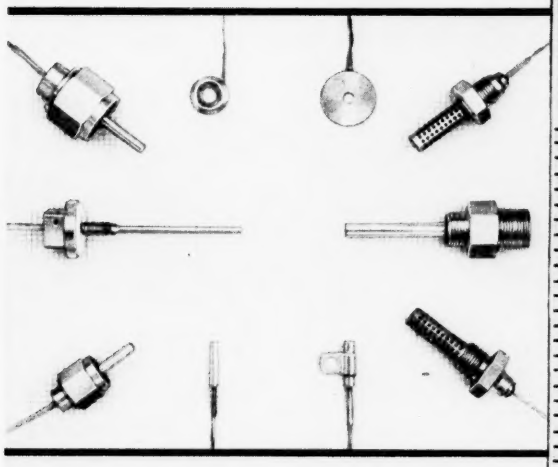
Engineers For Advanced Projects: / Interesting, varied work on designing transistor circuits and servo mechanisms. Contact Mr. Robert Burns, Personnel Manager, in confidence.

For more information circle **40** on inquiry card.

For the highest degree of *Accuracy*
in AIRBORNE TEMPERATURE INSTRUMENTATION



HIGH OUTPUT • RESISTANCE-TYPE TRANSDUCERS

Arnoux high resistance temperature probes are designed for telemetering and other applications requiring high signal levels. Models are available in a wide variety of physical configurations for measuring surface, fluid, and air temperatures.

- Output up to 5 volts without amplification.
- −320°F to +500°F range with ±2% linearity. (Special units are available up to 1600°F.)
- Nominal resistance values: 100 to 20,000 ohms.
- May be used in AC or DC Bridge circuits.
- Meets MIL-E-5272A specifications.
- Calibration curve supplied with each probe.

When used with ARNOUX miniaturized companion "TME" system, 20K transducers provide 5 volts output for as little as 150°F change.

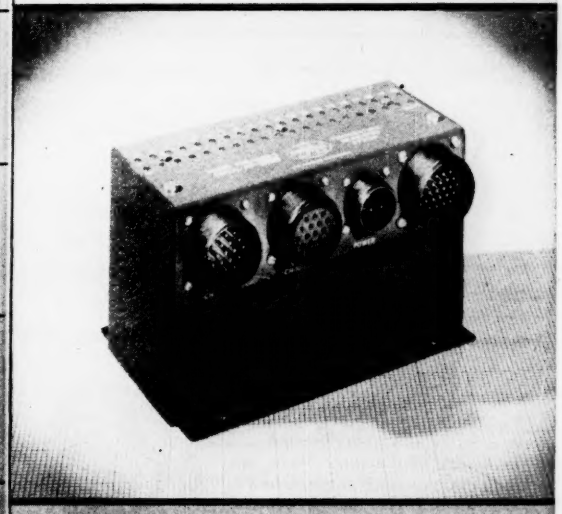
Write for Bulletin 300

MINIATURE MULTI-CHANNEL TEMPERATURE MEASUREMENT SYSTEM... full scale output 5 volts

ARNOUX "TME" is a completely self-contained system designed for operation with ARNOUX special resistance-type transducers. Models are offered in 7, 14, and 20 channel capacity. The unit contains two precision mag-amp type, regulated D.C. power supplies, series connected with common neutral, for excitation of the transducers in half bridge circuitry.

- Power requirement: 115 volts, 400 cps.
- Power consumption: 20 channel model requires less than 20 watts.
- Balance and attenuation controls for each channel.
- No vacuum tubes or transistors used.
- Output voltage and impedance characteristics — directly compatible with F.M. sub-carrier and P.W.M. coder input requirements.
- System stability: within 1% throughout MIL-E-5272A environmental.
- Dimensions: 20 channel model: 7" x 4¼" x 3", wt. 5½ lbs.

Write for Bulletin 500



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ARNOUX CORPORATION

Designers and Manufacturers of Precision Instrumentation

For more information circle 41 on inquiry card.

MARSHALLTOWN

DIAPHRAGM GAUGE

FOR ACCURATE PRESSURE MEASUREMENT IN OUNCES OR INCHES OF WATER

Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

Available in standard dials (reading in inches of water) 0-15" -0-30" -0-60" -0-100" -0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

Write for details and price. LOOK TO MARSHALLTOWN FOR ONE OE THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

MARSHALLTOWN MFG. COMPANY
MARSHALLTOWN 3, IOWA

For more information circle **42** on inquiry card.

READ

any surface temperature with Alnor® PYROCON

Equipment...material...metallic or non-metallic...flat, curved... revolving or stationary—you can read every surface temperature accurately in less than 3 seconds!

Compact, complete in precision design, this rugged instrument assures highest standards of speed, accuracy and dependability.

Alnor Portable Pyrocons come in scale ranges to 2000° F., with thermocouples for every application. You'll find full details on the Pyrocon exactly suited to your operations in Bulletin 4257. Send for your copy now. Write: Illinois Testing Laboratories, Inc., Room 518, 420 N. LaSalle St., Chicago 10, Ill.

Alnor

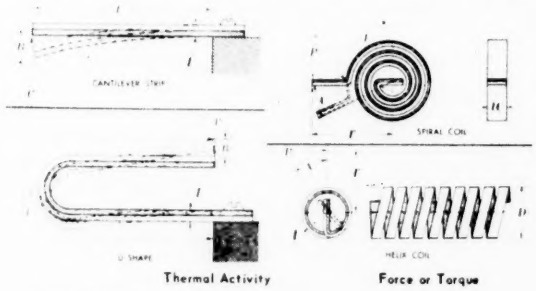
PRECISION INSTRUMENTS FOR EVERY INDUSTRY

For more information circle **43** on inquiry card.

BRIEFS—CONTINUED

Thermostat Metal Elements

Truflex S125 is a nonmagnetic thermostat metal . . . Truflex Thermostat Metal Elements can be made into various elements, such as cantilever strips, U-shapes,



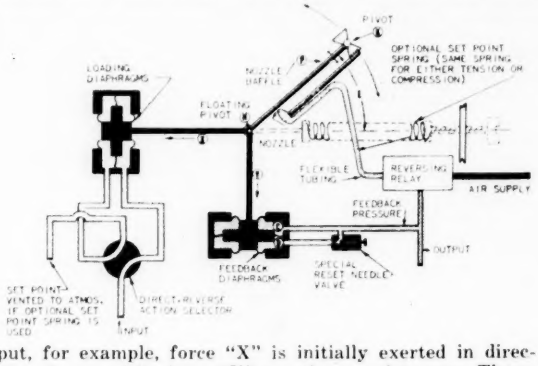
	Thermal Activity	Force or Torque
Cantilever Strip	$B = \frac{c_2(T_2 - T_1)L^2}{t}$	$P = \frac{\sigma_2 Bwt^3}{L^3}$
Coils	$A = \frac{c_1(T_2 - T_1)L}{t}$	$P = \frac{\sigma_1 Awt^3}{Lr}$

discs, reversed elements, simple beams, spiral and helix coils, etc . . . (*From new* 104-*page Loose Leaf Catalog—including contacts, clad metals, etc.—Metals & Controls Corp., General Plate Div., Attleboro, Mass.*)

For this literature circle **209** on inquiry card.

Type VC Pneumatic Controller

Operating principle of the VC controller is the null-balance-vector principle as developed by Republic . . . Controller is in static equilibrium and forces "X" and "Y" are each equal to zero when input pressure corresponds to set point loading and pressures in feedback diaphragms have equalized. If this condition is upset by an increase in input, for example, force "X" is initially exerted in direction shown, while force "Y" remains equal to zero. Therefore, force "X" tends to displace floating pivot "H". As a result, nozzle baffle "P" is lifted from the bleed nozzle (movement is actually not more than a few thousandths of an inch) and nozzle pressure drops, causing the reversing relay to increase output pressure . . . Range of values of controlled variable, which corresponds to final control element's full operating range, may be adjusted from 2 to 500 percent of total span of values of controlled variable . . . (*From new* 4-*page Folio* 57-2, *Republic Flow Meters Co.*, 2240 *Diversey Parkway, Chicago* 47, *Ill.*)



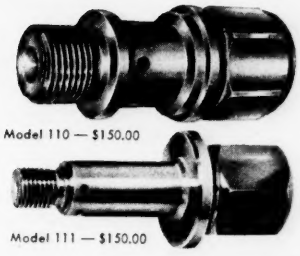
For this literature circle **210** on inquiry card.

Diaphragm Valve

Functionally, the operating feature that seals the fluid within the valve body is the diaphragm. The disc, inde-

Continued on page 245

NC CONTROLS



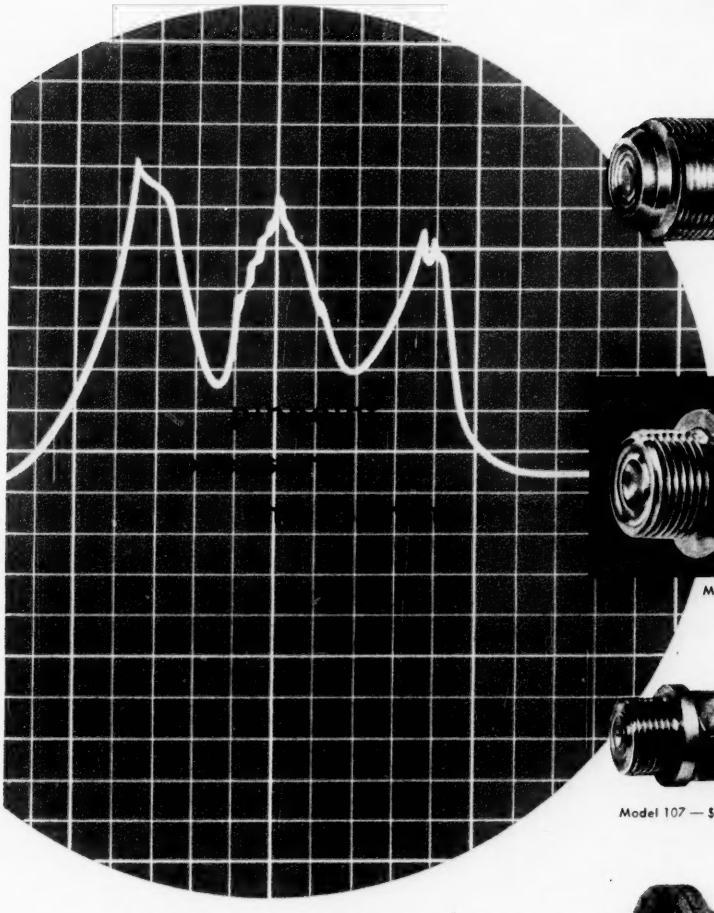
Model 110 — $150.00

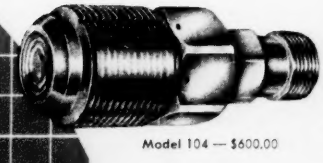
Model 111 — $150.00

High Temperature Adapters

For use with Norwood Controls EP air-cooled Transducers where temperature of the pressure medium is between 250°F and 600°F, such as in extruding and molding processes. Suitable for pressures up to 10,000 psi.

accurate



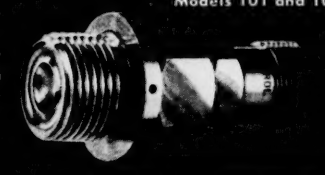


Model 104 — $600.00

Model 104 Pressure Transducer

For high pressure applications in blast analyses, gun barrel pressures, hydraulic high pressures, etc. Frequency response: flat from 0-20,000 cps.

versatile



Models 101 and 102 Pressure Transducers

Highly accurate, versatile transducers for dynamic pressure measurements requiring high frequency response (flat from 0-20,000 cps). Ranges from 0-100 up to 15,000 psi.

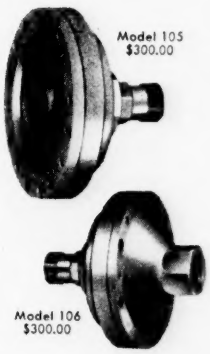
Model 101 — $275.00 Model 102 — $295.00

rugged

Model 107 — $600.00

Model 107 Pressure Transducer

Water-cooled, high frequency transducer for pressure studies under very high temperatures. Can be exposed to gas temperatures above 5000°F without damage. All welded construction for any applications, including highly corrosive liquids and propellants.



Model 105 $300.00

Model 106 $300.00

Models 105 and 106 Low Pressure Transducers

For pressure ranges 0-25 and 0-50 psig. Utilize same strain tube assembly as models above. May be used under conditions of extreme vibration as encountered in measuring shock waves in open air.

NORWOOD CONTROLS catenary diaphragm pressure transducers have established new standards of reliability in pressure measurements in dynamic systems . . . gasoline and diesel engines . . . jet engines . . . rocket motors . . . high pressure, high temperature chemical reactions . . . hydraulic and pneumatic systems.

Write for Data Sheets covering Norwood Controls transducers; *which have recently been substantially reduced in price.* **Norwood Controls Unit, Detroit Controls Division, 937 Washington St., Norwood, Mass.**

AMERICAN-Standard PRODUCTS

AMERICAN-Standard

DETROIT CONTROLS DIVISION

For more information circle **44** on inquiry card.

MICROVOLTS
without pre-amplification!

403

$580.

FEATURING

AMPLIFIERS: Direct coupled amplifiers with single-ended or balanced input.

EXTREME SENSITIVITY: 5 millivolt to 500 volts full scale, continuously variable. Additional sensitivity for short term measurements, with resolution down to 20 microvolts.

FREQUENCY RANGE: DC to 300 KC.

Y AMPLIFIER CALIBRATION: 5%.

SWEEPS: 19 calibrated linear sweeps, 0.5 sec/cm to 0.5 usec/cm. Calibrating accuracy, 5%.

EXPANDED SWEEP: Any 10 cm portion of 50 cm sweep may be expanded 4 times and positioned on screen.

Price **$580.00**
Slightly higher in 50 cycle areas

TYPE 403R Rack mounted version, electrically identical to Type 403 $595.00

Complete Details On Request...

The Type 403 is the most sensitive oscilloscope commercially available. It permits direct measurements from low output transducers such as strain gages, pressure pickups, accelerometers, and others that normally require preamplifiers.

When used as a direct reading voltmeter, the Type 403 offers stability of better than 1 millivolt per hour for all ranges from 500 volts all the way down to 1 millivolt full scale. A super sensitive range is available of 1 millivolt full scale (100 microvolts per scale division) for short term measurements.

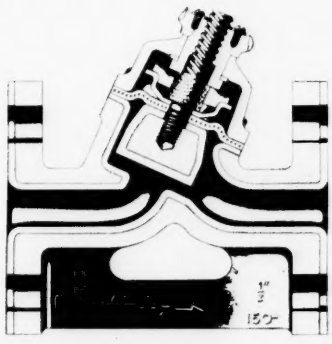
This outstanding performance is wrapped in the nicest package in the industry. The 403 features "human engineering" resulting in easier operation, complete accessibility and unsurpassed reliability backed by a 5-year guarantee.

ANOTHER OF THE 400 SERIES

DU MONT

TECHNICAL SALES DEPARTMENT,
Allen B. Du Mont Laboratories, Inc., Clifton, N. J.

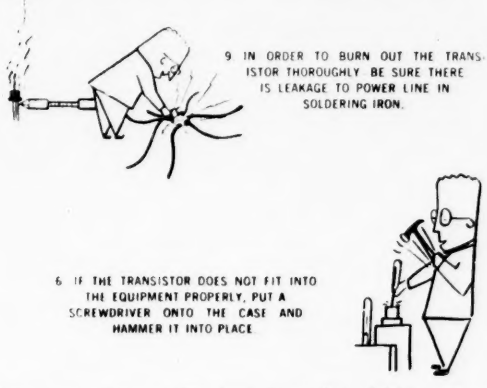
For more information circle **45** on inquiry card.



pendent of the diaphragm, closes the valve . . . The abrasive action of the fluid flow and the pressure are primarily absorbed by the disc, rather than the diaphragm . . . On vacuum service the vacuum in the closed position is exposed to the molded disc area only, and in the open position the diaphragm is fully supported and cannot move except by manually or mechanically turning the stem. Various actuators may be used with the valve.—(*From new 6-page Bulletin* 800, *W. S. Rockwell Co.*, 200 *Eliot St., Fairfield, Conn.*)

For this literature circle **211** on inquiry card.

How Not to Use Transistors


9. IN ORDER TO BURN OUT THE TRANSISTOR THOROUGHLY BE SURE THERE IS LEAKAGE TO POWER LINE IN SOLDERING IRON.
6. IF THE TRANSISTOR DOES NOT FIT INTO THE EQUIPMENT PROPERLY, PUT A SCREWDRIVER ONTO THE CASE AND HAMMER IT INTO PLACE.

(*From new 4-page illustrated pocket folder, General Transistor Corp.*, 91-27 138*th Place, Jamaica* 35, *N. Y.*)

For this literature circle **212** on inquiry card.

Isotopes Used for Research

Baird-atomic has compiled for your convenience the following reference data as a contribution to better Analysis:

Isotope	Half Life
K-42	12.4 hr.
Cu-64	12.9 hr.
Na-24	14.8 hr.
Br.82	35.9 hr.
Y-90	2.5 d.
Au-198	2.7 d.
I-131	8.05 d.
P-32	14.3 d.
Rb-86	18.6 d.

(*From new* 40-*page Catalog A*-1, *Baird-Atomic, Inc.*, 33 *University Road, Cambridge* 38, *Mass.*)

For this catalog write direct to Baird-Atomic on company letterhead.

photo-oscillograph users:

ATTENTION!

NOW...

PRE-PRINTED PHOTO CHARTS

Did you know that the manufacturer of almost any standard photo-recording oscillograph can supply you with photo-sensitive recording charts *already printed with amplitude and reference lines?*

He can do this because of a new, exclusive process developed by the Bristol special chart service for printing to accuracies of ± 0.005 inch through photo-sensitive emulsions.

If your photo-oscillograph uses charts up to 12 inches wide on ultra-violet or tungsten-sensitive positive papers, ask your chart supplier about Bristol pre-printed photo charts.

This outstanding new development is just one of the special charts you can get from Bristol. Our chart-printing facilities can handle strip charts up to 29 5/8 inches across and circular charts up to 12 inches diameter.

Some of the available papers include: highest quality regular chart paper in standard thicknesses; wax-coated, heat-sensitive, chemically-coated, electrically-sensitive or pressure-sensitive papers; papers for metallic marking; foil-type laminates for extreme dimensional stability; card stock; carbon coated (or smoked) papers. Also special punchings or printing to any mathematical law.

Write for complete data on the Bristol special chart printing service. The Bristol Company, 154 Bristol Road, Waterbury 20, Conn. B 16

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **46** on inquiry card.

You Can Count On... to Pay Off!

It's the **Original Equipment* idea . . . which simply means that, when you're figuring on electrical or mechanical counters in any new product, it pays to *design them in, when you begin.*

For then Veeder-Root quite likely can save you time and money by adapting or modifying a *standard* counter to your needs, instead of a special which you might specify on your own. This solves the counter problem . . . and saves you time in engineering, purchasing and assembly.

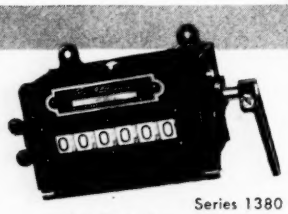
What's more, you give your product new sales-advantages: Direct-reading digits, instead of hard-to-read dials and verniers . . . instant remote indication if needed . . . up-to-the-minute performance records that serve as a basis for production-*Count*rol, and as proof of your performance guarantee. So don't let counters take a back seat in your new-product plans. *Design them in, when you begin* . . . it pays in many ways. Do you have the newest Veeder-Root Catalog? Write

Series 1205
Reset Magnetic Counter

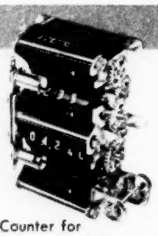
Everyone Can Count on Veeder-Root

INCORPORATED

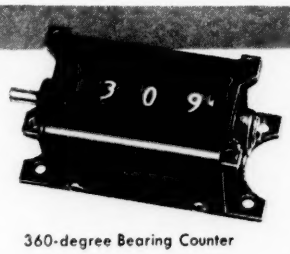
Hartford, Conn. • Greenville, S. C. • Chicago • New York
Los Angeles • San Francisco • Montreal
Offices and Agents in Principal Cities



Series 1380
Box-Type Counter (Ratchet, Revolution, or Geared)



4-bank Counter for Radio Transmission Equipment

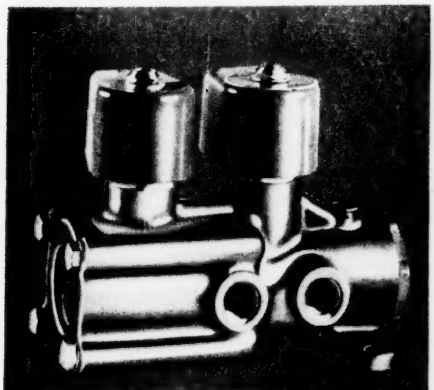


360-degree Bearing Counter

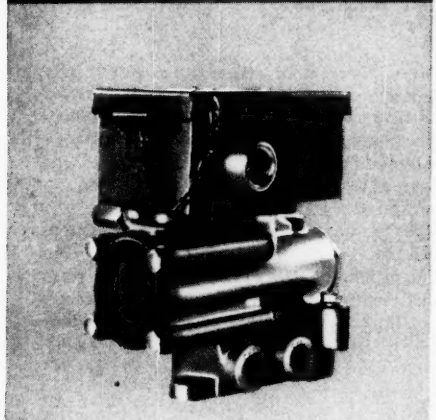
For more information circle **47** on inquiry card.

Now available: full line of ASCO 4-way solenoid valves

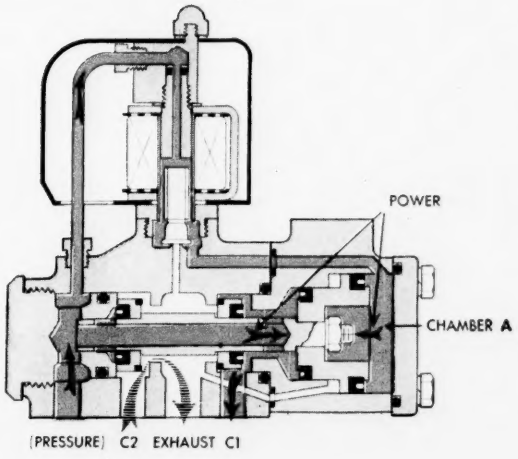
Single Solenoid: operates when solenoid is energized; returns automatically when de-energized.



Dual Solenoid: operates when either solenoid is energized; will not return until opposite solenoid is energized. Solenoids may be energized continuously or momentarily.



J.I.C. Construction: single and dual solenoids, with sub-plate mounting.



power driven in both directions by line pressure

Now available in ⅜" through 1" sizes, these valves are positive in action. When the solenoid is de-energized, *line pressure* applied to the top of the pilot core forces it off the seat, eliminating possible sticking caused by residual magnetism. *Line pressure* is applied to Chamber A, moving the piston-disc assembly to the left. When the solenoid is energized, Chamber A is exhausted and *line pressure* drives the piston to the right.

absolutely tight seating — no leakage

Combination of metal to metal and resilient seating provides dead tight shut-off — even on air. No grinding, lapping or close adjustments are necessary.

Available in standard, watertight or explosion-proof solenoid enclosures, the Bulletin 8344 permits cycling rates to 850 per minute — mounted in any position. Design simplicity eliminates maintenance problems.

J.I.C. construction available

These 4 way valves are available in all sizes to meet J.I.C. (Joint Industry Conference) standards. Valves are provided with sub-plates, vapor-proof solenoid enclosures, and manual overrides, and are electrically inoperative when the cover is removed.

New ASCO Condensed Valve Catalog No. 201 is now available. Write today for this basic reference on solenoid valves.

AUTOMATIC TRANSFER SWITCHES
SOLENOID VALVES ELECTROMAGNETIC CONTROL

Automatic Switch Co.
52-F Hanover Road, Florham Park, N. J. FRontier 7-4600

ASCO

For more information circle **48** on inquiry card.

CLOSING THE CONTROL LOOP AUTOMATICALLY

...with an RW-300 DIGITAL CONTROL COMPUTER

INCREASED PROFITS FROM EXISTING PLANTS

For the first time, a digital computer is available to close the control loop automatically—to provide greater profits by increasing plant throughput, improving product quality, and decreasing operating costs. The new RW-300 Digital Control Computer is engineered specifically to solve the difficult problems of process plants in the oil refining, chemical, metals, and other industries.

The desk-size RW-300, with built-in input and output equipment, is designed to be connected directly to process instruments and controllers. It continuously monitors the instruments, makes the required computations and decisions, and adjusts the set-points of the process controllers. In addition, it prints records of operating data. RW-300 computer control is fast, accurate, and dependable.

The computer's program of instructions, stored in a magnetic drum memory, can easily be completely revised without modifying the equipment. As a result, the RW-300 can also readily handle changing control problems such as those encountered in pilot plants and research centers. The RW-300 can in addition serve as a versatile computing data logger and as a general-purpose computer.

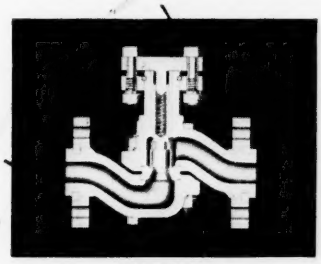
Ramo-Wooldridge has a staff of experienced systems engineers to handle applications of the RW-300. If your company has a problem in process control, pilot plant operation, or advanced data logging, write to: Director of Marketing, Dept. IA-802, The Ramo-Wooldridge Corporation, 5730 Arbor Vitae Street, Los Angeles 45, California.

The Ramo-Wooldridge Corporation

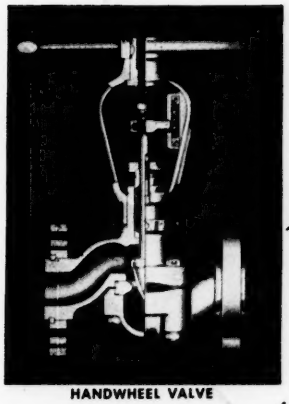
5730 ARBOR VITAE STREET • LOS ANGELES 45, CALIFORNIA

For more information circle **49** on inquiry card.

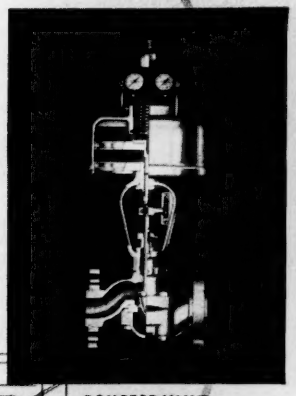
AROUND-THE-CLOCK RELIABILITY with Annin



CHECK VALVE



HANDWHEEL VALVE



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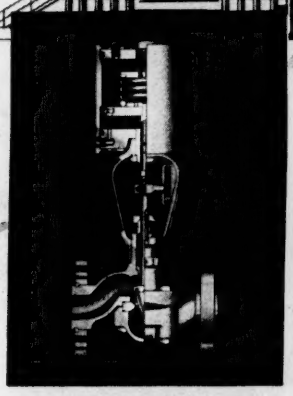

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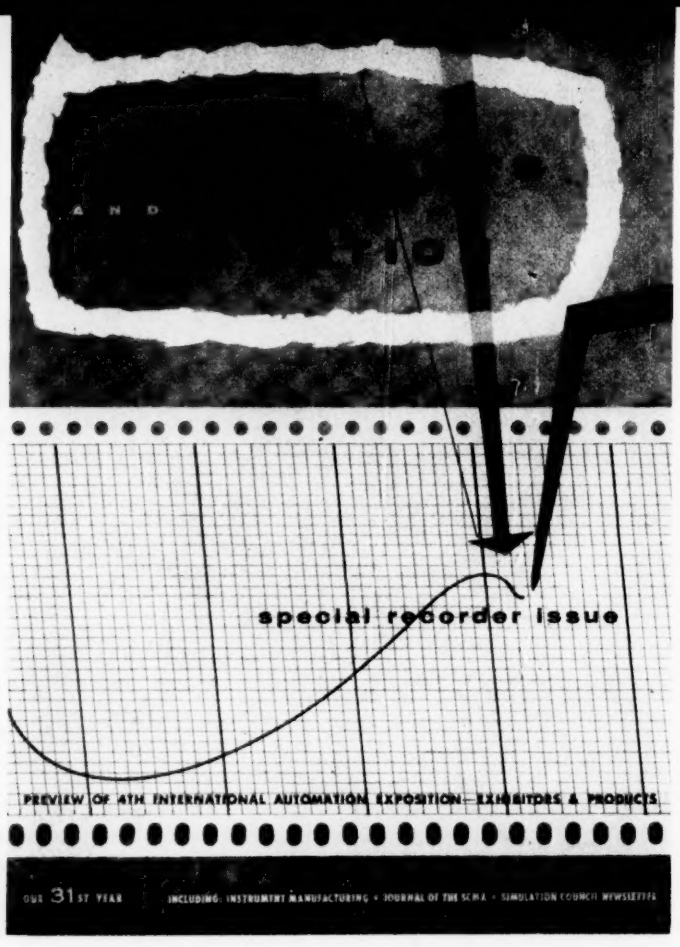
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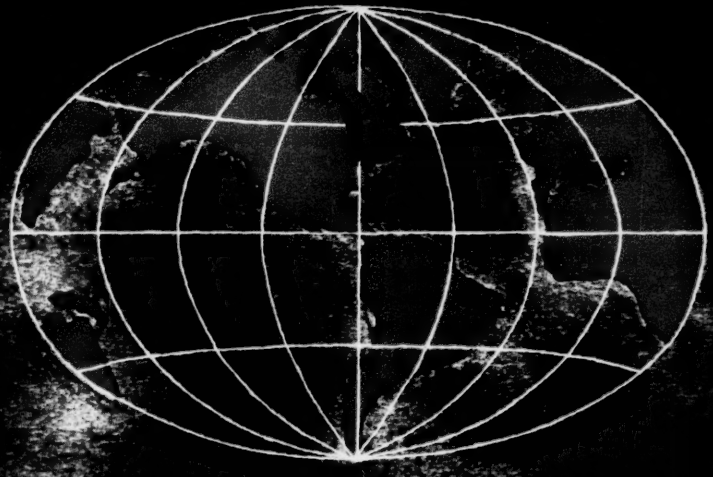

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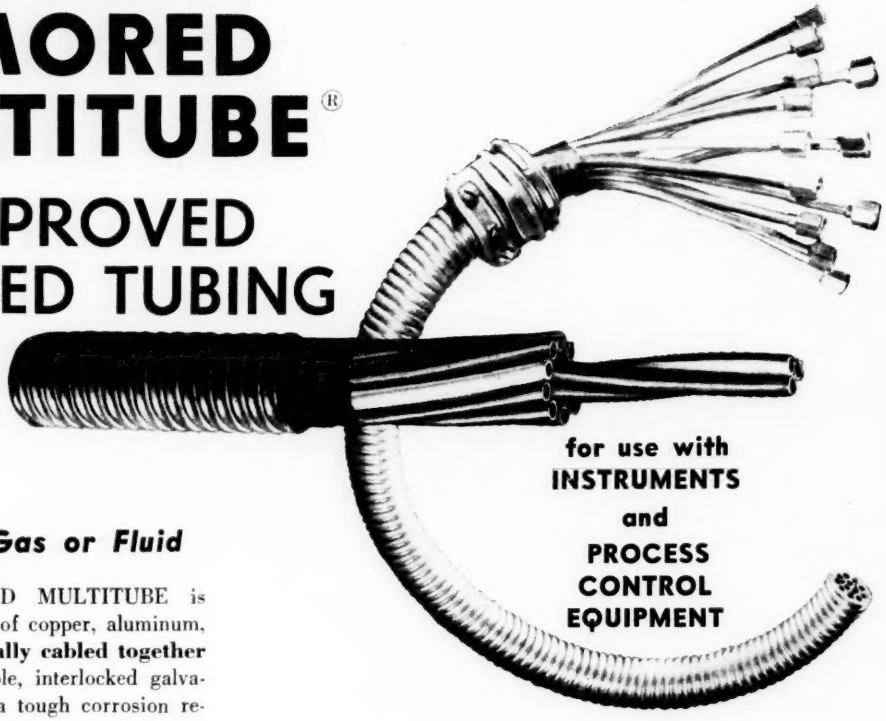

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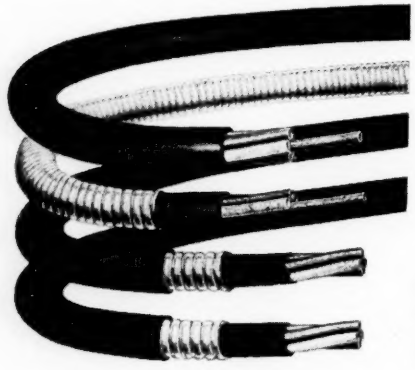

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events

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March 24-27

National Convention of Institute of Radio Engineers, Inc., Waldorf-Astoria Hotel and New York Coliseum, New York City. For information write E. K. Gannett, IRE, Inc., 1 East 79 St., New York 21, N. Y.

April 16-25

International Instruments, Electronics & Automation Exhibition, Olympia, London. For information write T. E. Rees, 9 Argyll St., London, W. I., England.

May 6-8

1958 Western Joint Computer Conference of the Institute of Radio Engineers and the American Institute of Electrical Engineers, Ambassador Hotel, Los Angeles. For information write David Parry, 6363 Wilshire Blvd., Los Angeles 48, Calif.

May 12-14

4th National Instrumental Methods of Analysis, ISA Analysis Instrumentation Div. & Houston Section, Shamrock Hilton Hotel, Houston, Texas. Contact R. D. Eanes, L&N Stenton Ave., Phila. 44, Pa.

May 21-23

Instrumentation & Automatic Control of Power Systems—Today & Tomorrow, ISA Power Div. and the New York Section. Contact W. Welch, Long Island Lighting Co., L. I., N. Y.

May 31-June 8, 1958

European Congress of Chemical Engineering and ACHEMA Congress, Frankfurt a.m., Germany. For information write DECHEMA, Dechema-Haus, Rheingau-Allee 25, Frankfurt a.m., West Germany.

June 2-4

1958 National Telemetering Conference sponsored by the A.I.E.E., A.R.S., I.S.A. and I.A.S., Lord Baltimore Hotel, Baltimore, Md. For information write T. E. Meyers, Wolfe & Mann Mfg. Co., 28th & Sisson St., Baltimore 11, Maryland.

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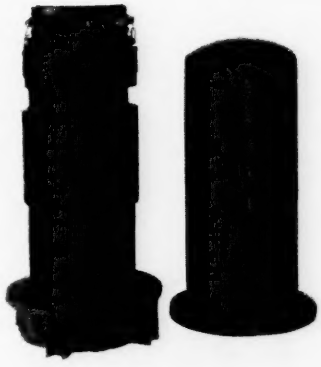

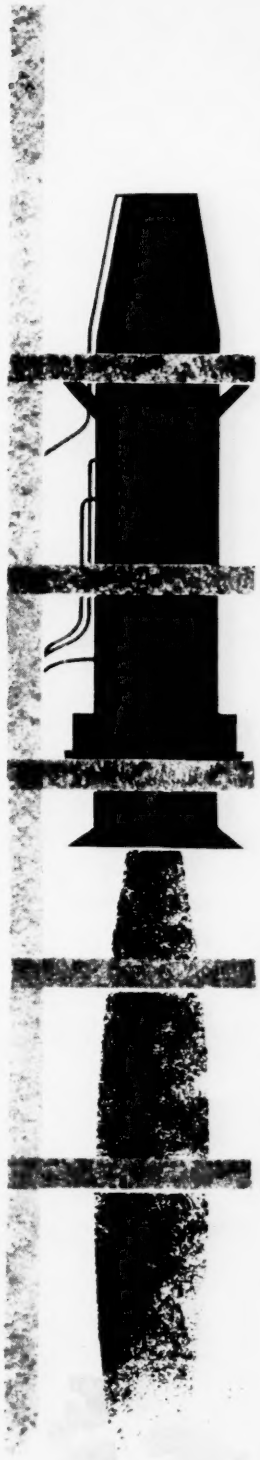

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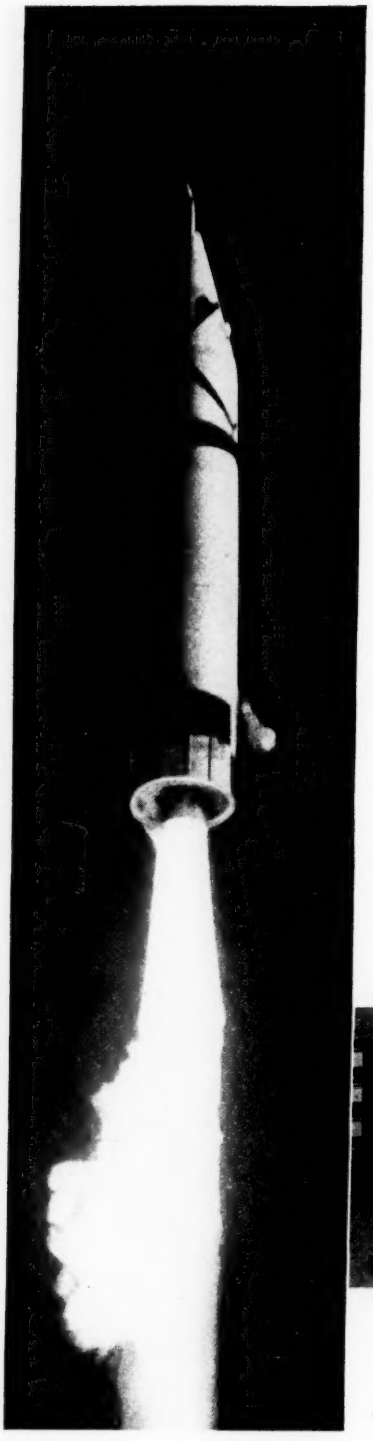

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editorial

A Prophetic Prediction and Program

In July of 1956, *INSTRUMENTS & AUTOMATION* published an editorial which has become, in light of recent developments, of prophetic significance. This editorial stated (page 1293, July, 1956, *I&A*):

> "Every nation is emphasizing technology and technological education. Not only is the world's population accelerating, but the number of technically trained persons is increasing at even faster rate. The action of each practical idea or scientific discovery falling on each of these minds is known to be regenerative—productive of more than one path of further discovery. Indeed, modern channels of communication between trained scientists have made it possible for one idea—the analog of one neutron—to activate a million receptive minds—the analogs of fissible fuel.
>
> "The fissible material of the social reactor—the element that absorbs one idea to produce two or more—is the technically trained mind. Technical education thus becomes the real source for the raw fuel—and the teacher becomes the truly key element. The work of one teacher can lead to a thousand trained minds in but a few years, and each mind becomes more raw stuff for the social reactor. Hence the single most efficient way to prime the social reactor is to develop a large and competent group of educators.
>
> "This point emphasizes the seriousness of our present situation, wherein our national teaching staff is not only inadequate but declining in adequacy in the face of increasing need. No practical person would invest his money at a negative rate of interest—yet most of our nationally-collected funds are being invested in just this way—in military hardware that will be obsolete in a few years. This is not only a negative rate of interest, but a high one at that. In contrast, every dollar spent on teachers and schools represents positive return, more trained minds, more fuel for our own social reactor.
>
> "Another factor associated with chain reactions should be kept in mind. When the critical mass is exceeded, the resultant effect often dwarfs all known experience. We as a nation are not adding to the mass of our reactor as fast as are other nations, and whereas the raw fuel for the social reactor takes years to develop, the output shows no such time lag. *Thus the first nation to exceed the critical mass of the social reactor will have indeed discovered the key to the future—and others will be hard-pressed to meet its achievements* [italics added]. Evidence exists that other nations are more aware of this fact of modern life than are we, and that their social reactors may soon be more technically advanced than ours.
>
> "What can we do to bring our own social reactor to full power output? The answer is a national effort comparable to that which produced the nuclear reactor, but aimed at producing the world's best educational system and teaching staff. Let us find the money for this effort within our military and strategic budget; let us de-emphasize the nuclear reactor in favor of the social reactor; let us slash military expenditures and devote the money to a nation-wide education program, to schools, laboratories, and teachers.
>
> "This is a program that would bring our own social reactor to a power level above that of the nuclear reactor—a program which, in contrast with our present course, would tend to prevent the social reactor from being destroyed by the nuclear reactor. And whereas the fallout of the latter will destroy the bone marrow in your children's children, the fallout of the former will assure them a full life of individual satisfaction and happiness, and will nourish all the arts and humanities.
>
> "But we are not moving in this direction today."

And we are still not moving in this direction. Billions are being allocated to scholarships—at the expense of school construction funds. We are now going to subsidize students—at the expense of teachers. There is still no awareness in Washington of the essentiality of placing a thoroughly trained teacher, with adequate facilities, in front of a normal-sized class.

It is not that our nation is far behind any other. It is simply being outpaced by nations that have analyzed modern educational problems more honestly and are solving them with greater dedication. Meanwhile, our nation drifts; billions of words are mouthed about plan after plan; billions of dollars are appropriated hysterically for palliatives—while our classrooms become more crowded every day and our teachers suffer ever greater financial and teaching pressures.

The irony of ironies is the placing of blame for our loss of leadership on the school system and its workers. "They" have been lacking in foresight; "they" let the school system deteriorate; "they" did not attract enough scientists and engineers. This despite the fact that "they" have for years been asking for more and better schools, teachers, and teaching facilities. We as a nation do not only face our problems—we blame scapegoats for our own weakness, shallowness and lack of foresight. We even resort to blaming our children—"let's make them study on Saturdays."

The science of the calculus is powerful because it operates on rate change, not absolutes. It is not so important that we are behind in any one field of technology; the real danger is that our rate of educational growth is behind that of the "enemy." Any freshman college engineering student should be able to prove from this fact that the future is lost unless we change our *rate* of advancement. This can be done only by a program such as we suggested in 1956.

It is now a prophetic program.

MHA

This state-of-the-art report reveals current practice and attempted instrumentation for control of blast furnaces in Britain.

Blast Furnace Instrumentation

D. W. GILLINGS

WORLD PRODUCTION of steel has been increased greatly by development of improved techniques, including greatly widened scope of instrumentation. The open-hearth furnace has received the most attention, particularly measurement and control of the liquid and gaseous fuels which can be carried out well with existing instruments.

The iron blast furnace has not received the same concentration of effort, partly because there are critical tasks which still await effective instruments and cannot be tackled readily with existing knowledge; some general descriptions of present practice have appeared in the literature.[1,2,3]

Present Instrumentation

The stages of the ironmaking process are set out in Fig. 1. The main process is the smelting of lump iron ore with hard coke in large blast furnaces. The furnace is essentially a large chemical reactor in which the coke is burned with hot air under pressure, under conditions permitting reduction of the ore to iron as molten pig iron. This is the first appearance of metal in the several stages of the steelmaking processes. The raw materials are carefully prepared in modern plants, mainly by crushing and screening the ore to yield uniform material for smelting. Sintering plants also are installed at many ironworks to convert dusty ironbearing materials to a uniform product of acceptable size by mixing with coke breeze and initiating combustion, generally on a downdraft grate.

Fig. 1 shows that instrumentation and control are used at several critical points. The measurements fall generally into two classes, those dealing with furnace gases, and those with handling solid raw materials. These measurements also can be classed as either routine or experimental. The distinctions are shown in Table 1 by single and double brackets.

The operation of blast furnaces is guided largely by the *blast pressure*. Great importance is attached to control of the descent of materials through the furnace, and the ease with which the air can be blown through and thus ensure a high rate of burning of coke, which leads to a high rate of smelting. The resistance of the furnace column is indicated directly by the blast pressure.

The *temperature* of the blast air is also a critical figure which, in part, determines the combustion temperature and the heat balance and distribution of heat exchange in the furnace. It may be a steady figure for a given practice, but the actual value may range between 400°C and 900°C, depending a great deal on the type of ore used.

Blast volume is generally recorded at the inlet to the blowers, with closed-loop control. Owing to the increase in temperature and pressure, the actual volume of the hot air reaching the furnace will be different, and may be variable. No measurement is made normally of the volume of gas leaving individual furnaces, and total volume from several furnaces indicates nothing about furnace operation. The temperature of the gas leaving each furnace, however, is always recorded and forms an important guide to furnace operation; in general, low temperature is an index of efficient smelting.

The *pressure of top gas* is largely determined by the resistance of the gas offtakes, and in normal operation heretofore has been on the order of 1 to 2 psig. In

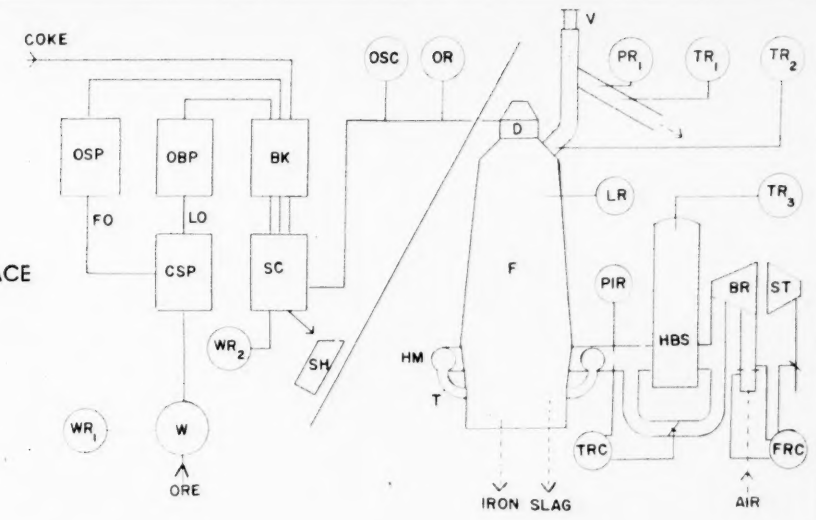

FIG. 1. BASIC BLAST-FURNACE INSTRUMENTATION.

FO: Fine ore stream
LO: Lump ore stream
W: Weighbridge
CSP: Crushing and screening plant.
OBP: Ore bedding plant
OSP: Fine ore sintering plant.
BK: Bunkers
SC: Scale car
SH: Skip hoist
D: Bell top and distributor
F: Furnace stack
HM: Hot air blast main.

T: Tuyeres
BR: Air blast blower
ST: Turbine drive
HBS: Hot blast stove
V: Pressure overload vent.
WR1: Weighbridge weight print recorder
WR2: Scale car weight print recorder
OSC: Operation sequence control
OR: Operation recorder
LR: Stock level recorder
PR1: Main dirty gas pressure recorder

TR1: Main dirty gas temperature recorder
TR2: Furnace top refractories temperature recorder
TR3: Stove dome refractory temperature recorder
PIR: Blast pressure indicator and recorder
TRC: Blast temperature recorder-controller
FRC: Blast air flow recorder-controller (cold side)

recent years there has been extensive development of "high-top-pressure" working. For this, the gas offtake is restricted, and the pressure may be kept at 15 psig or higher. This effectively reduces the velocity of gas through the furnace, especially at the stockline, and permits harder driving—that is, a greater air rate and iron output, and reduced loss of iron as dust carried over with the flue gas. Operation of the furnace is not radically altered, but provision must be made by gas locks to retain pressure, and the instruments for top gas pressure must have adequate range.

The foregoing are among the main measurements which guide operation—in conjunction with analytical data on the raw materials (ore, coke and sinter).

Developments and Experimental Instruments

Blast volume measurement is normally carried out on the cold air and is subject to error because of leaks and losses in the air heating system. For investigations of furnace efficiency there are advantages in having a direct measurement of air rate, and this has been done experimentally by constructing a refractory concrete Venturi into the hot blast main near the furnace. Measurement of the volume of gas leaving the furnace also has been attempted. Useful results have been obtained with a Pitot head design with sufficient free volume to avoid choking with dust, which is most troublesome in all top-gas measurements.

While temperature of top gas is a measure of furnace efficiency, a more direct indication can be obtained from the *composition* of the gas leaving the furnace. This is a mixture of carbon monoxide and carbon dioxide, with a large proportion of nitrogen from the air. The ratio of monoxide to dioxide is an indication of the completion of the ore reduction, and thus of the process efficiency.

Many attempts have been made to record top-gas analyses, but so far no universally accepted method has evolved. Recent experimental work has been done with infrared absorption instruments. Earlier, attempts were made with thermal conductivity methods. On the European continent, elaborate instrumentation has been put into service that uses successive direct absorption and combustion instruments. Like other top-gas measurements, these methods are rendered difficult by the high dust content of the flue gas.

Various methods have been applied for measurement of the dust content itself as an indication of furnace operation, and particularly of loss of dust entrained from the furnace. *Photoelectric absorption* methods have been used for this duty; in instances where measurements of the much lower dust content of cleaned gas were required, *light scattering* has been investigated.

Burden Permeability

Although the important improvements in control of furnace operations have been achieved most widely by the pre-furnace control of raw materials, which is essentially an open-loop method, there have been investigations into direct, automatic, closed-loop control of furnace driving. In one scheme[4] the rate of blowing is controlled by a signal indicating the pressure drop

TABLE 1—INSTRUMENTS USED AT TYPICAL IRONWORKS

PLANT	PROCESS	MEASUREMENT	RANGES AND UNITS	INSTRUMENT
ORE PREPARATION	Wagon intake	Unit weights	Up to 50 tons/unit	Print-record weighbridge
	[Reclaim from bedding]	[[Rates of transport on belt]]	100's tons/hr.	Belt weight recorder
	Transfer to furnace bunkers	Weights on transfer car	Totals of 30 tons/charge	Print-record weighbridge
BLAST FURNACES	Coke intake	[Coke feed rate]	10's or 100's, tons/hr.	Belt weight recorder
		Weights of charge units	Totals about 30 tons/charge	Print-record weighbridge
	Dump to furnace	Records of movements	No units: up to 20 operations	Operation recorder
		Stockline level [[and profile]]	Depth (ft&in) and movements by tenths of inches	Balanced winch and Selsyn recorder/indicator
	Air intake to blowers	Air volume	50,000 cfm or more	Orifice and differential recorder
		Stove refractory temperatures	[up to 2200°F]	Thermo-junction and recorder
	Gas to stoves	Gas usage	1000's cu ft/min	Orifice and ring balance recorder
	Air heating	Air temperature	[up to 1500°F]	Thermo-junction and recorder
	Blowing air to furnace	[[Air mass flow]]	Corrected scfm	Venturi near bustle pipe
		Air pressure	10-30 psig	Bourdon indicator-recorder
		Furnace throat wall temperature	about 450°F	Thermo-junction and recorder
	Top gas disposal	Gas temperature	300°F—1000°F	Thermo-junction and recorder
		Gas pressure	10-60" WC [or 5-15 psig in high-pressure operation]	Hg-float recorder [Bourdon for high pressure]
		[Gas volume]	[about 100,000 scfm]	Pitot tube and ring-bal. recorder
		[[Dust content]]	Relative indication by density	Photoelectric measurement directly or after impinger stage
SINTER PLANTS	Raw materials feed	Feed table rates and power loading	Table rpm	Electric tachometer and wide-scale ammeter [[direct belt weight recorder]]
	Mixing and water control	Water feed rates: Sample and spot test		Water pressure gage or Venturi indicator: Sampling for spot measurement by acetylene pressure or other moisture indicator.
	Ignition of mixture	Gas flow to igniters	scfm	Orifice and differential recorder
	Suction exerted - air flow traversing bed	Suction	up to 60" WC	Differential recorder
		Total airflow	up to 60" WC	Orifice for flow
		Suction at each stage	Order of 100,000 scfm	Suction indicated by liquid or diaphragm manometers. [[Separate Venturis at each windchest leg]]
		Airflow at each stage	[[tens of thousands cfm]]	
	Gases leave bed	Gas temperature	Max. about 1200°F	Thermo-junction and recorder

[ ] Single brackets indicate measurement or range encountered in special practice.
[[ ]] Double brackets indicate experimental measurements only.

across the furnace. This simulates the established manual control method by diverting air blast to atmosphere to correct irregular descent of furnace "burden" as indicated by high pressure drop. When air pressure is reduced, support for the furnace burden is thus reduced and smooth descent restored. In a sense, this control could operate in opposition to the regular control of constancy of air volume by the closed-loop system at the blowers. This automatic control operates much more rapidly than the usual manual method. It is, of course, based only on changes in gas flow and offsets, but does not directly remedy the variation of burden permeability. Note: The long time while the material is in the furnace gives good static efficiency for the heat exchange between the gas and the solids, but the dynamic behavior (the lag in detecting and correcting disturbances originating in the solid materials) is unfavorably influenced.

Stockline Measurement

The instruments described so far have been mainly for measurements of gases, but there are others dealing with movement of the solid raw materials, particularly at the stages of charging the furnace and following the descent of the stock within it. There are two stages of development of stockline measurement.

At every modern plant an indicator and recorder is used to follow position and rate of movement of material in the furnace. In British and American furnace practice, regular movement of materials in the furnace is usually one of the prime objectives of good operation, and the *stockline level indicator* is an important instrument. Its principle is quite simple. A rod is suspended from a wire rope and electric winch which exerts just enough torque to prevent the rod falling from vertical, but not enough to raise it free from a

FIG. 2. CONTROL ROOM
of British sintering plant.

surface on which it rests. Its movement thus follows stockline movement, and is indicated and recorded.

Suggestions have been made for an instrument which records the *profile* of the stockline across the furnace. This profile could give data on the differential material and gas flow at regions in the furnace at different distances from the center, and be a further guide to uniform movement and operation. Experiments have been made with ultrasonic echo-sounding equipment fitted in the furnace top to range down to the stockline, but it has not proved possible to achieve good transmission of sound.[3] Mechanical indicators have been used with some success for limited experimental periods.[9]

Sinter and Ore Preparation Plant

Sintering at iron ore plants is essentially a special example of combustion, the mixed "fuel" being about 5% coke and 95% fine ore and the like. The factors controlling sintering are the fuel content of the mix, and the rate at which air is drawn through it.[6,7] The latter is of great economic importance as it governs the plant output, and control of the air-flow rate is effected by control of water content which determines the permeability to air. This is best achieved by controlling the delivery rate of fine ore to the plant and metering water additions to maintain the optimum value.

Direct measurement of air flow through the bed also has been attempted to give a more direct indication of permeability. This direct measurement has been made with a Venturi built into one of the downdraft legs of the moving grate sinter plant. As with the blast furnace, there is a limit to the effectiveness of control based on gas flow; the open-loop control effected by preparation of raw materials always is of critical importance. Fig. 2 shows part of the instrument installation at a sinter plant in Britain.

Solids Instrumentation

Although the opinion of many engineers is that equipments like the balanced belt and electronic control combinations widely accepted in light industry are not yet fully developed for the arduous duty at steel plants, the importance of applying these controls to ironworks materials is fully recognized.[8] The better the materials control and analytical information, the better the open-loop, feed-forward control of the furnace, and the less critical the need to attempt the inherently difficult problem of feed-back control of the furnace itself. There is thus a need for consolidation in development of solids handling and "flow" measurement. Feedback control, so well established in other process industries making fluid products, also is rendered difficult by the problem of determining the quality of products from ore plants and furnaces, which in turn arises from problems in development of sampling and analysis units.

The main purpose of instruments has been to serve the operator's skill and experience and thus help to keep the blast furnace—once found so intractable—in continuous, efficient operation.

Acknowledgements

The author wishes to acknowledge with thanks the guidance and help received from former colleagues in the research and production organizations of the British steel industry. The descriptions and opinions given are the author's own and are not necessarily endorsed by any steel-industry or other organization.

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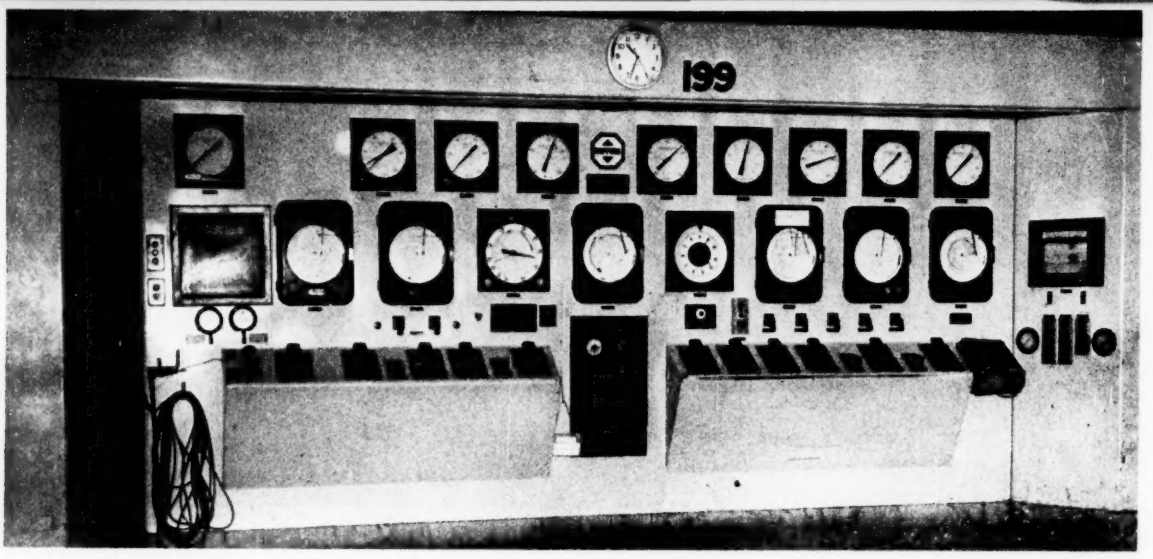

FIG. 1. PANELBOARD installed for each of nine furnaces at Fairless Works. Instruments are identified in Fig. 2.

Programming
OPEN-HEARTH COMBUSTION

Here is the open-hearth instrumentation and programmed combustion control used at U.S. Steel's Fairless Works.

L. W. EISENHART
United States Steel Corporation

AT FAIRLESS WORKS the open-hearth shop consists of nine furnaces, each capable of producing 330 tons of steel per heat. Tap-to-tap time is about ten hours.

Virgin coke oven tar is used as a base fuel, with Bunker C fuel oil supplied to meet fluctuations in fuel requirements. A maximum firing rate of 150,000,000 Btu/hr is maintained, with tar providing a substantially constant rate of about 30,000,000 Btu/hr. The checker system is the double-pass type comprising a hot and cold pass.

All combustion controls are operated pneumatically and all recording and indicating meters are pneumatic signal receivers functioning from transmitters located in the "kitchen," or cellar. The burners at each end of the furnaces are the three-barrel type and are housed in a refractory-covered water-cooled enclosure, called a "doghouse." The top barrel fires oil, the center barrel fires tar, and the bottom barrel injects oxygen into the combustion area for flame enrichment during melt-down.

Presented at 7th Annual Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March 1957.

Combustion Control System

The basic functions accomplished by the combustion control system are:

(1) Control of the rate of fuel tar supply from the operating panel by a manually adjustable pneumatic signal, with provision for remote manual control of tar valve position.

(2) Control of the total heat input rate by adjustment of the rate of oil firing (with allowance for the tar firing rate). Provision is made also for remote manual adjustment of the oil valve position.

(3) Control of the supply of air for combustion, with compensation made automatically for the quantity of oxygen used for flame enrichment.

(4) Control of atomizing steam quantities supplied for oil burners and tar burners, provision for manual adjustment of the fuel-steam ratio, and additional provision for remote manual control of steam valves.

(5) Control of oxygen quantities supplied for flame enrichment and provision for remote manual positioning of oxygen control valves.

(6) Control of furnace pressure through automatic operation of waste-heat boiler dampers and stack

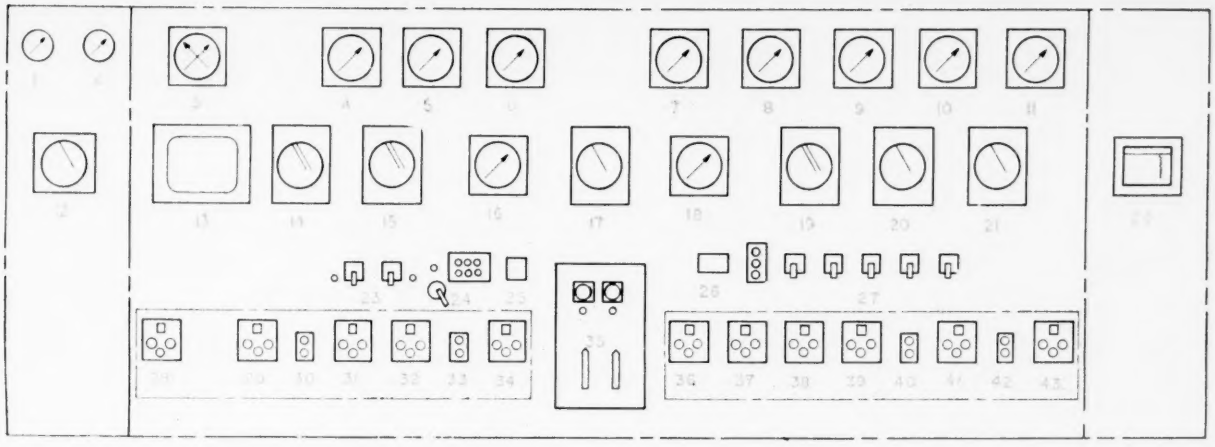

FIG. 2. PANELBOARD LAYOUT.

Top row:

1. Steam pressure gage for tar atomization.
2. Steam pressure gage for oil atomization.
3. Decarburization oxygen indicator (2 point).
4. Steam for tar indicator and control set point.
5. Tar flow indicator and control set point.
6. Total fuel indicator and control set point.
7. Furnace pressure indicator and control set point.
8. Total air flow indicator and control set point.
9. Oil flow indicator and control set point.
10. Steam for tar indicator and control set point.
11. Combustion oxygen indicator and control set point.

Second row:

12. Bath temperature recorder.
13. Television monitor.
14. Decarburization oxygen (2 point).
15. Steam for tar and tar flow.
16. Roof temperature.
17. Furnace pressure.
18. Temperature difference.
19. Steam for oil and oil flow.
20. Combustion oxygen.
21. Total BTU and air flow.
22. Checker temperature.

Third row:

23. Manual reversal and emergency fuel.
24. Panel alarm for roof temperature, checker temperature and time.
25. Manual-automatic roof temperature selector.
26. Temperature difference differential adjuster.
27. Pistol grip switches for doors.

Bottom row:

28. Steam for tar.
29. Tar flow.
30. Tar flow set point.
31. Steam-tar ratio.
32. Total fuel-air ratio.
33. Furnace pressure set point.
34. Stack damper.
35. Reversal unit.
36. Bailey damper.
37. Steam for oil.
38. Steam and oil ratio.
39. Oil flow.
40. Total fuel.
41. Combustion oxygen.
42. Oxygen set point.
43. Combustion air.

dampers, with provision for remote manual control of all power positioners.

In addition, all parts of the combustion control system operate in conjunction with signals issuing from the furnace reversal mechanism.

Operation

The control systems for the various functions are shown in separate diagrams:* the references made to each diagram will be found under the corresponding sub-headings.

Fig. 1 shows the control and instrument panel installed for each furnace; the panel layout is shown in Fig. 2. Note: The bath temperature recorder (12 in Fig. 2) and the flue temperature indicator (at far left in Fig. 1) are interchanged on alternate furnaces. The top row of instruments consists entirely of indicators. The second row comprises recorders, with the exception of the checker temperature difference controller. At the center of the vertical panel in the lower row is the furnace reversal unit. The console at either side of the panel houses manual and automatic relays for dampers, fuel and steam, oxygen, air, and furnace pressure.

This panel arrangement gives the furnace operator a centralized station for observation and combustion control during the working of a heat.

*Drawings courtesy Hagan Chemicals & Controls, Inc.

Fuel Control

The control system for tar and oil fuels and atomizing steam for each is shown in Fig. 3.

Total heat input is of greatest importance in any stage of a heat. A relay mounted on the main panel (for manual adjustment by the operator) transmits a pneumatic signal indicating the desired fuel input. This signal is imposed on a totalizer-type relay, which also is subject to a second signal issuing from the roof-temperature recorder-controller to prevent excessive roof temperature. This second signal modifies the heat input signal whenever necessary for roof protection.

The output signal from the totalizing unit (roof temperature cutback relay, at left in Fig. 3) indicates the demand for all fuels. This signal is transmitted to a second relay where the quantity of tar being fired is subtracted from the total fuel requirement. The difference then becomes the demand for oil.

The oil demand signal is transmitted to a final relay, which has a feedback connection for controlling purposes. The output signal from this controller is transmitted to a diaphragm-type oil control valve that adjusts the rate of oil firing automatically. A panel relay station provides remote manual operation of the oil control valve.

The input of tar fuel is subject to the manual adjustment of the tar input relay at the main panel. The signal from this relay is transmitted to a totalizer-type

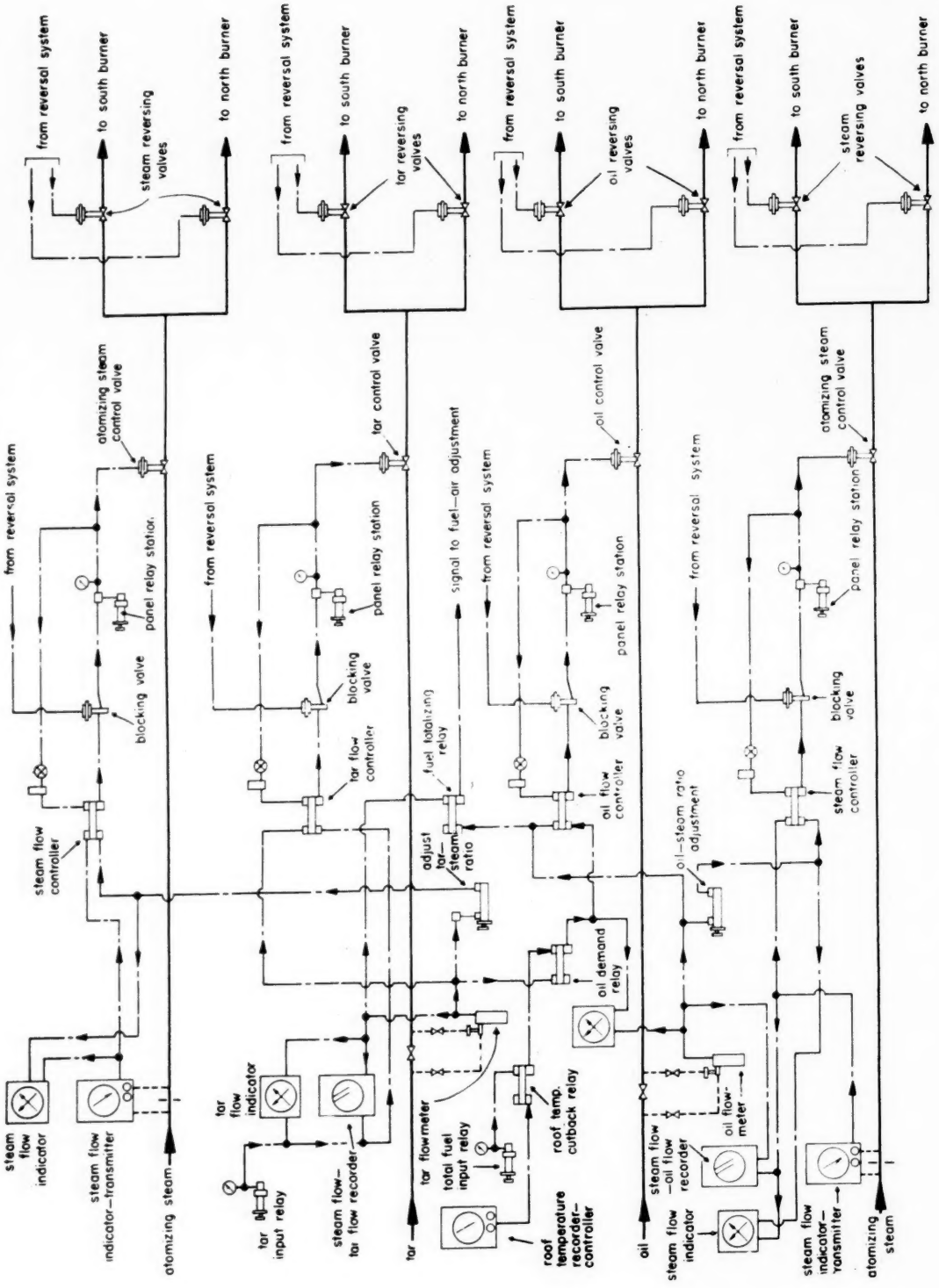

FIG. 3. FUEL CONTROL

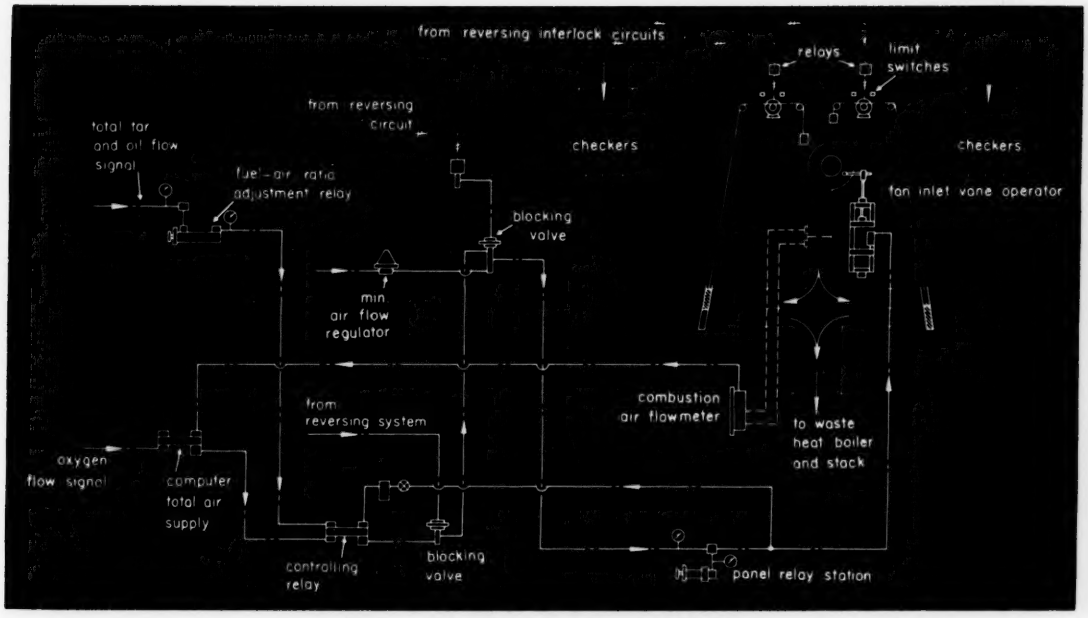

FIG. 4. COMBUSTION AIR CONTROL.

relay and the demand signal is balanced by the signal transmitted from the tar flowmeter that shows the actual rate of tar flow. The output from the tar flow controller is transmitted (as in the case of the oil flow controller) through a manual control station at the panel and to the tar control valve.

The supply of atomizing steam for tar fuel firing results from a signal at the tar-steam ratio adjustment relay; this signal is transmitted to the steam flow controller and is balanced at that controller by a signal indicating the rate of actual steam flow to the tar burners. Output from the steam flow controller again is transmitted through a panel relay station and then to the atomizing steam control valve.

A similar arrangement establishes the atomizing steam supply for oil firing in accordance with a definite ratio between the measured rate of oil flow and the rate of steam flow. Here again the measure of actual steam flow balances the demand signal from the oil-steam ratio adjustment relay, and the output of the steam flow controller passes through a manual control station at the panel to the steam control valve.

Oxygen is supplied the furnace through a set-point relay, balancing controller, blocking valve, etc., in a similar fashion. The signal representing oxygen flow is received by a relay in the air-flow control system that corrects combustion air flow according to the amount of oxygen added to the furnace.

Blocking valves in the signal lines to the two fuel control valves and to the two atomizing steam control valves receive signals from the furnace reversal control system. These blocking valves hold signal pressures to the several control valves at the value that existed at the time of reversal. This assures that the rate of firing immediately following a reversal will be the same as the rate prior to reversal.

Indicators for the rates and set points show steam flow, tar flow, oil flow, and atomizing steam flow. Recorders are provided also for steam flow and tar flow, and for steam flow and oil flow. All recorders and indicators are of the pneumatic-receiving type, acting from signals transmitted by the several elements of the control system.

Reversal valves also are included in the tar, oil, and atomizing steam connections to the burners at either end of the furnace; these valves are actuated by the furnace reversal system.

Combustion Air Control

The supply of combustion air is determined by the rates of supply of both tar and oil fuels after compensation for the oxygen used for flame enrichment. Signals for oil flow and tar flow are transmitted to a fuel totalizing relay that indicates the total liquid fuel input. This total fuel signal is transmitted to a ratio-type relay (upper left in Fig. 4) for manual adjustment of the fuel-air ratio. The output signal of the ratio relay is transmitted to a controlling relay, which transmits a signal through a panel relay station to the forced-draft-fan inlet-vane operator.

The combustion air flowmeter measures the output of the forced-draft fan and transmits its signal to the total air supply computer. A second signal, taken to this same computer, indicates the rate that oxygen is supplied to the burners; this is added to the measurement of fan output and is used as a balancing signal at the controlling relay.

Furnace Pressure Control

The furnace pressure control system is shown in Fig. 5. A pneumatic signal is established at a set-

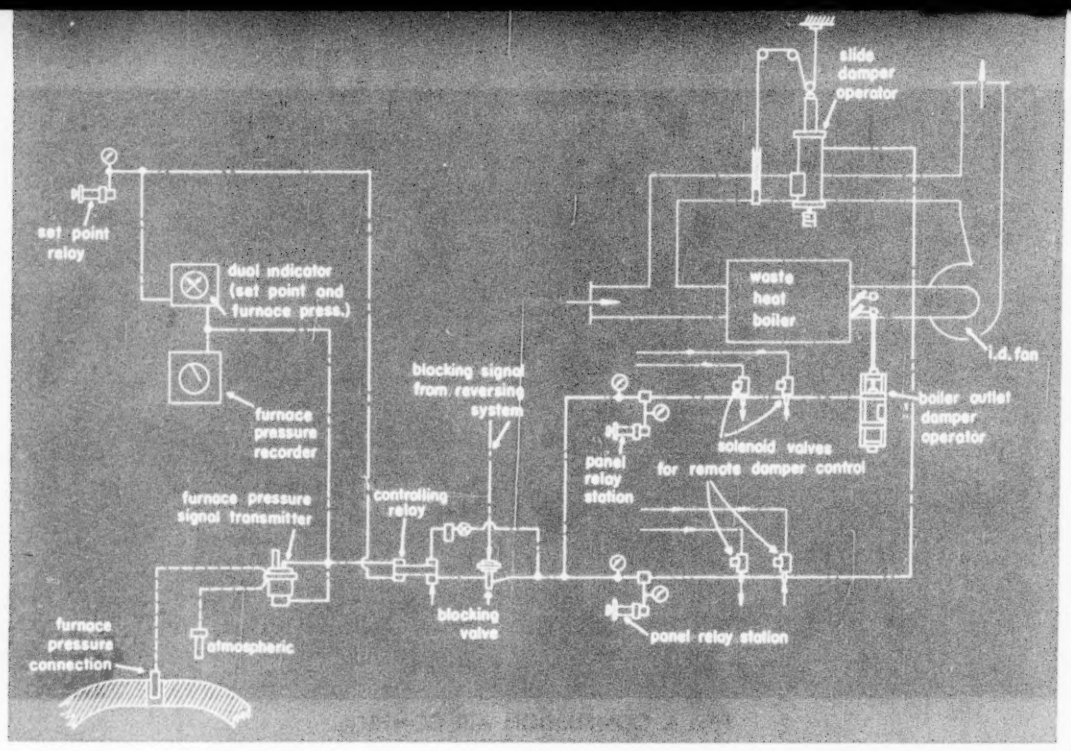

FIG. 5. FURNACE PRESSURE CONTROL.

point relay on the panel, and a diaphragm-type signal transmitter develops a signal representing pressure at the roof of the furnace (left in Fig. 5). These two signals are transmitted to a controlling relay, which maintains furnace pressure corresponding to the signal from the set-point relay. The output of the controlling relay is transmitted through two panel relay stations to the waste-heater boiler outlet damper and the slide damper. These dampers are moved automatically to maintain the desired furnace pressure. Panel indicators show set point and furnace pressure. The blocking valve fixes damper positions during reversal. The solenoid valves in the signal lines to the two power positioners provide remote damper control from the panel.

Reversal Control

The reversal control system permits reversal of combustion air flow and fuel flow to the burners, and blocks the fuel demand system during reversal. Reversal is actuated through either a time cycle or temperature difference in the checker chambers.

Program Control

An auxiliary panel, not shown, is mounted in the main panelboard house at each furnace. Solenoid valves, actuated from an electric selector switch at the main panel, and set-point relays permit the operator to select the correct basic operating conditions for the melting, hot metal, ore boil, lime boil, and working periods.

The maximum flows for each stage of the heat are set on the auxiliary panel, while the operator introduces manual adjustments from the main panel if necessary. Note: The roof cutback control still reduces fuel, steam, and air automatically if there is any danger of damage to the roof.

The fuels group at Fairless Works is charged with the responsibility of recommending combustion practices. Records establish trend data on any furnace combustion practice. Plotting of these curves indicates that, during any stage of the heat, firing rates from one heat to the next are repeatable and that deviations from this firing rate follow an upward trend which can be correlated to the length of the furnace campaign. Thus any optimum schedule has fuel, air, and steam schedules that vary with the stages of the heat and can be corrected as the furnace efficiency decreases. The problem becomes one of observing that an operator uses a recommended quantity of fuel, air, and steam at any stage of the heat.

Evaluation of programmed combustion practice is long and difficult. Programming appears to stabilize one set of variables inherent in open-hearth practice to allow the operator more time for concentration on the metallurgical aspects of furnace operation. It offers the further possibility of allowing those shops where hot-metal availability, charging practices, and end product are of a predictable nature to program operation through a time cycle. It poses the problem for the combustion engineer to prove that he can best prescribe the ultimate in heat input values to the open hearth process, and also poses the problem for the operators to prove that, given the ultimate in a heat transfer rate, metallurgy can be duplicated on a furnace.

ROBERT L. SIGL, Detroit Steel Corporation

Modern Open Hearth Control

Hydraulic combustion control, pneumatic reversal control and electric temperature control are combined in this modern open hearth that tapped its first heat in 1954.

OPEN HEARTH CONTROL is being vindicated daily by the results being obtained in the impressive number of modern shops recently brought into being. Although furnaces themselves are bigger and better designed, the complete control of operating conditions through instrumentation is one of the fundamental keys to successful operation. Let us examine the joint approach of the engineers and operators in applying combustion, reversal and temperature control to new furnaces at Portsmouth, Ohio.

Combustion Control

One of the first conditions to be considered for open-hearth control is furnace pressure. The importance of this factor has been recognized for years, predating the automatic control era to the day when a first helper always kept a stinger at the end door.

The control of this condition is more complex than it seems. A pressure measured in hundredths of an inch of water in the furnace body is controlled by actuating the stack damper. Between these two points are the furnace uptakes, slag pockets, regenerators, and flue systems.

For these reasons, special attention was given to the equipment selected to control the furnace pressure. It was our opinion that hydraulic control was superior for this application and, therefore, the pattern was set for hydraulic combustion control. To minimize the recognized fire hazards, a nonflammable fluid was used as the hydraulic medium.

Fuel Input

The furnaces are fired with either straight fuel oil or a combination of oil and natural gas at 20 psi. The maximum replacement of oil by gas was limited to 60% and the combination burner was designed to deliver the gas above the liquid fuel.

Presented at 7th Iron & Steel Instrumentation Conference, Pittsburgh, March, 1957.

Two regulators control this combination firing. A total-fuel-input regulator summarizes the fuel oil flow independently, or in combination with gas, and converts the impulse to input in Btu's per hour. A second regulator, termed a "percentage gas control," allows the first helper to vary the amount of gas being fired from 0 to 60% of the total fuel. These regulators control the fuel flows by hydraulic-operated valves in the respective fuel lines. Presenting fuel inputs on a Btu basis wherever possible has simplified the evaluation of firing rates for the first helper.

Natural gas is reduced to the operating pressure by a master regulator and distributed to all furnaces. Fuel oil is heated at a centrally-located temperature-controlled bank of heaters that supply all furnaces.

Fuel-Air Ratio

The control of the amount of combustion air required to efficiently burn the fuel being fired on an open hearth is subject to many influences. Air measured on the discharge of the fan is automatically ratioed to the total fuel input by hydraulically varying the fans' intake louvers. The values presented, however, can be considered representative only of the amount of air delivered to the burner. This control is most effective only under conditions of optimum furnace pressure and minimized infiltration. Satisfactory results can be obtained through its use if a shop has an organized fuel program, which includes periodic waste-gas analyses.

Atomizing Steam

One of the factors in the development of maximum flame temperatures is the proper use of atomizing steam. It had been our experience that the so-called atomizing steam controls were not adaptable to the open-hearth furnace. Therefore, we regulate the air loading of the diaphragm-operated steam reversing valves from a panel-mounted station. Rather than depend on a static pressure measurement for manipulation of the atomizing steam, a meter measures the actual flow.

Reversal Control

A standard panel-mounted type of reversal control system electrically actuates the reversing dampers and pneumatically operates the fuel and steam reversal valves, which are located on platforms at the ends of the furnace. Reversal patterns include straight

time, a combination of time and first-pass checker temperatures, and manual pushbutton operation. The individual burner fuel and steam reversal valves are piped so that they can be bypassed and the furnace reversed manually from an auxiliary stand in an emergency.

Reversal control has proven to be one of the most valuable pieces of equipment applied to the furnace. It not only maintains balanced thermal conditions and provides minimum reversal times, but also releases the first helper to follow his heat more closely.

Temperature Systems

One of the most controversial subjects of open-hearth instrumentation has been roof-temperature control. Past experiences have been so disappointing that it was not included in the instrumentation of some of the newer furnaces.

In our opinion, this is one open-hearth control failure which cannot be attributed to furnace deficiencies. It appears, rather, that its poor record has resulted from several conditions, the principal one being the accuracy of temperature measurement and calibration.

Two methods have been employed to measure roof temperatures. The first is to install the radiation head in the front or backwall and focus the detecting element on the furnace roof. The problems encountered in such an open furnace measurement resulted in unreliable measurement and excessive maintenance.

The other method is to sight the head into a refractory block installed in the furnace roof. Two types of blocks have been used as radiation targets. In one, a relative roof temperature is obtained by measuring the temperature of a refractory diaphragm recessed in the block several inches from the inside surface of the roof. The second block is designed so that the measurement more closely corresponds to actual temperature of the roof surface.

The first type block was installed in the original roof construction and considerable trouble was experienced in maintaining a consistent calibration. On subsequent rebuilds it has been replaced by the second type, and most of the serious difficulties have been eliminated.

The roof-temperature control limits the temperature to a safe maximum by reducing fuel input. Regular calibration checks, and a realization that the temperature indicated is not necessarily representative of all sections of the roof, can make this control a good operating medium. It is particularly valuable when the roof is at critical temperatures during heavy bath reactions, or at times when the first helper is blocked from his furnace.

Checker Temperatures

Our decision to adopt a two-pass regenerator design made it important that the best possible temperature measurements be made of the first and second passes. Some failures of this type construction can be directly attributed to the fact that this matter was not given sufficient consideration.

The first-pass temperatures are measured by radiation heads sighting on closed-end refractory tubes installed in the regenerator roof. The temperature instrument operates in conjunction with the reversal control on the selection of the time-temperature pattern so that the furnace is reversed on preset differential or maximum first-pass temperatures.

The second-pass temperatures are measured by thermocouples installed in metallic protection tubes through the roof of these regenerators. Two additional recording points measure the temperature of the stack and the super-heated atomizing steam.

Instruments and Controls

For the convenience of the first helper, and to insure the maximum use of the control equipment, special attention was given to panel location and layout and to optimum visual indications of the conditions being measured and controlled. All of these indications are recorded simultaneously for daily analysis by open-hearth and fuel-department supervision. The fuel and steam flowmeters are equipped with integrators for fuel accounting and performance purposes.

The control stations are located across the floor and to the end of the furnace. They are offset in this manner to give the first helpers an unobstructed view of the front of the furnace during charging periods.

The panels are recessed in the control building, left open at the front and closed at the sides and back. The second stories of the buildings were fully enclosed and used as control rooms for the furnaces' electrical equipment.

By not enclosing the panel front it is not necessary to resort to a console arrangement to manipulate and set the controls remotely. Wherever possible, impulses are imposed directly on the meters and controls without the use of transmitting devices. These approaches not only result in considerable initial savings but also tend to keep the control application as fundamental and simple as possible. Provision is made in all cases for emergency operation in the event of control failure.

Modifications

Several minor changes were incorporated on the fifth new furnace recently put into operation. These changes include the following:

1. Indicating and recording of fuel-oil flow is performed by a positive displacement meter instead of an orifice meter. This allows the oil flow valve to control at the desired set point value and the meter to indicate and record actual oil flow conditions.

2. The stack damper goes wide open instead of blocking and holding when the reversal selector switch is set on the "blow" position. This is accomplished by a slight change in hydraulic piping and relieves high furnace pressures quickly in an emergency.

3. The oil flow control valve closes on reversals instead of blocking and holding. This change was made by adding switch contacts and a relay in the reversal system that work in conjunction with existing solenoid valves on the hydraulic system. This change prevents momentary oil flooding after reversal.

Instrumentation in Vacuum Induction Melting

FIG. 1. VIEW OF VACUUM INDUCTION furnace shows main instrument panel at rear of furnace, arc hot-topping control console beside operator, and operator's console on opposite side of furnace.

This review of the instrumentation attempted in controlling vacuum induction melting operations shows that basic problems still exist.

E. G. VOGT

Universal-Cyclops Steel Corp.

TABLE 1.—MELTING PROCESSES FOR HIGH TEMPERATURE METALS

Older Air Processes—Slag Protected:
- Basic Electric Arc
- Induction
- Consumable Electrode—Slag Protected (Kellogg)

New Vacuum Processes:
- Induction (Inductovac)
- Consumable Electrode

New Combination Processes:
- Basic Electric Arc or Induction + Consumable Electrode Vacuum = DUOMELT
- Induction Vacuum (Inductovac) + Consumable Electrode Vacuum = DUOVAC

New Pouring or Casting Refinements:
- Vacuum Degassing (Bochumer Verein)
- Linde Slag Process

TABLE 2.—PROPERTIES OF AIR VERSUS VACUUM MELTED METALS

	Tensile Properties		100 Hr. Rupture	
	Strength psi	Elong. %	Strength psi	Elong. %
M-252 (air)	100,000	7	29,000	12
(vacuum)	105,000	28	38,000	30
Waspaloy (air)	80,000	10	31,000	7
(vacuum)	105,000	35	42,000	19
Unitemp 90 (air)	76,000	8	28,000	10
(vacuum)	98,000	9	36,000	15

WHY is it necessary or desirable to melt under vacuum? There are two answers: (1) Certain metals (an example is titanium) cannot be melted in the presence of air and refractories and (2) those metals which can be melted in air often have better properties when melted under vacuum. Table 1 shows the various melting techniques for high-temperature metals.

We cannot detect much difference *chemically* between the results of vacuum and air melting. Air-melted material is contaminated with oxygen, nitrogen and hydrogen, but the quantities present are ordinarily measured in parts per million. However, reducing these gaseous contaminants from around 300 or 400 parts per million to perhaps 20 or 30 parts per million has a pronounced effect on the properties of the metal (Table 2). Also, the vacuum melted material is generally cleaner, microscopically.

The removal of gaseous impurities and some types of inclusions improves certain low-temperature properties, such as impact strength and fatigue strength. This improvement is of great importance to the manufacturer of tools and bearings. Improvement also is exhibited in high-temperature properties, which are

Presented at 7th Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March, 1957.

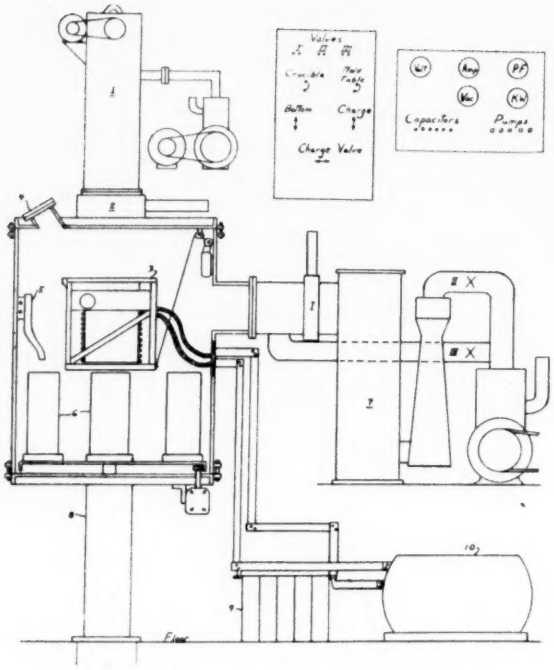

FIG. 2. SCHEMATIC OF THE VACUUM MELTING furnace. The charge chamber (1) is separated from the main tank by the gate valve (2). A separate mechanical pump is shown for this charge chamber. The induction furnace itself (3) is shown hooked to a capacitor bank (9) and an MG set (10). The vacuum pumping system for the main tank is shown at right. Under normal operation the gate valve (1) is open through a two-stage oil ejector pump (7) backed by a mechanical rotary pump.

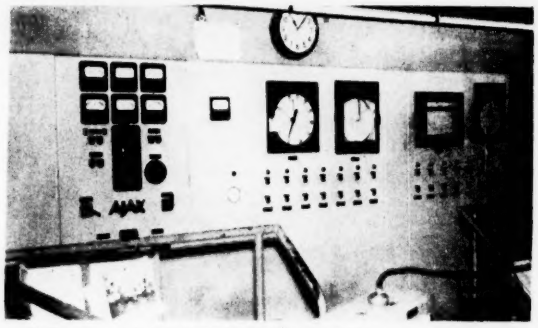

FIG 3. MAIN INSTRUMENT PANEL. On the left is the control panel for the induction power supply. The controls which are used most frequently are the generator exciter control and the control which puts different numbers of capacitors into the circuit to balance the inductance of the heating coil.

particularly important in gas turbines and jet aircraft engines. There are great improvements in ductility in some alloys. Even where strength is not improved, materials are usually far less brittle after vacuum melting.

As shown in Table I there is more than one type of vacuum melting process. Some of the older processes use an electric arc or induction melting. Both of these have been used for many years and are conducted under a blanket of molten slag. New vacuum processes include both induction and consumable-electrode heating.

Vacuum Degassing

Vacuum *degassing* processes (Table I), which were developed by Bochumer-Verein in Germany, use a conventional air melting furnace to melt the charge. The material is then poured into a ladle and placed in an evacuated chamber.

Any gases evolved from the surface of the melt are pumped away by a vacuum pump. Ladle degassing is not very effective because the gas can be removed only from the top of the molten metal. The hydrostatic head prevents gas from being evolved from any depth in the metal.

There is an apparatus that permits the molten metal to be transferred from a ladle under atmospheric pressure into an evacuated tank where the stream falls through the evacuated space and into a second ladle. The gas is removed from the droplets as they fall from one ladle into the other.

Vacuum degassing is effective in removing hydrogen and other gases from low-alloy steels. It is generally not believed to be effective in removing oxygen and nitrogen from high-alloy steels, and is a compromise between conventional air melting and vacuum melting. It is cheaper than vacuum melting and, in some cases, effective; in other cases it does not go far enough to accomplish what we like to accomplish in vacuum melting. Vacuum degassing is now being used on a fairly large scale by U. S. Steel.

Vacuum Melting

In a conventional furnace we have contamination possible from air, slag, and the refractories in contact with the molten metal. In an induction vacuum furnace the metal is melted by induction from a high-amperage, high-frequency alternating current flowing in the coils surrounding the metal. Here we can remove the slag and the atmosphere as sources of contamination and further refine the metal by removing gases from it by vacuum. The crucible surrounding the metals still remains the major source of contamination.

The vacuum arc *cold-crucible* process goes one step further in removing sources of contamination.

There are two separate vacuum melting processes —(1) vacuum induction melting and (2) vacuum arc melting. In most induction vacuum melting furnaces, a small chamber on top is separated from the main chamber by a large horizontal gate valve (Fig. 2). With this valve closed the vacuum can be broken and the top charging chamber removed or refilled. In this way we can recharge the furnace without affecting the vacuum in the main tank. The actual melting is done by induction in the middle of the main tank. When the charge is melted the furnace is tilted and the molten metal poured into one of several molds. In the furnace at Universal-Cyclops (Fig. 1) the molds are mounted on a turntable in the bottom of the tank.

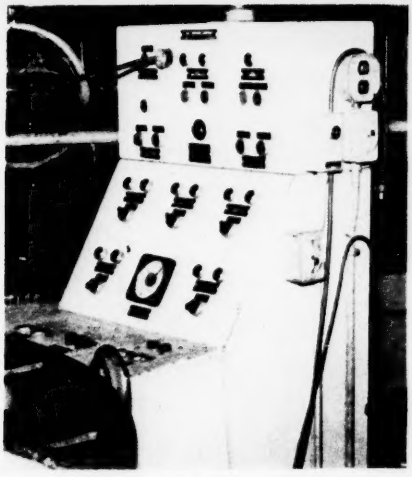

FIG. 4. OPERATOR'S CONSOLE.

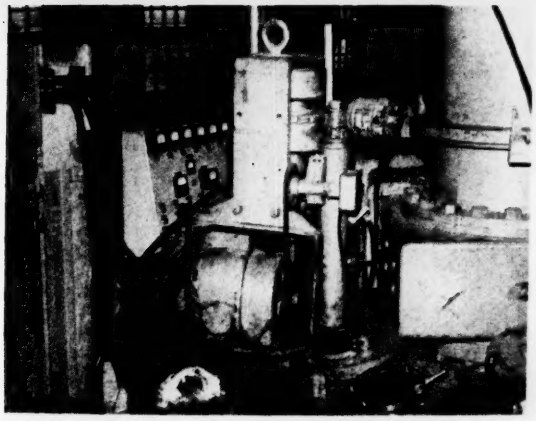

FIG. 5. ARC HOT-TOPPING APPARATUS; hot-topping control console is in background.

Instrumentation

The indicating instruments on which the operator depends most are *power-factor meter* and the *total KW input meter* (on right side of the left-hand panel in Fig. 3). Each of the other instruments has a red line indicating a danger point which the operator should not exceed under any conditions. The instrument on the next panel is an indicating pyrometer, a radiation-type instrument which has not been too satisfactory for the type of work being done. Its function is to measure the temperature of the molten steel in the furnace. The difficulty in using this type of instrument is that it is necessary to sight through a port glass on to the molten metal. It is difficult to keep these glasses clean and the instrument is not suitable with the furnace as presently designed. A special sight port for using this instrument is being designed into a new furnace.

The next instrument (under clock) is a hydrogen flowmeter. It was proposed originally to reduce the oxygen content of the bath by treatment with gaseous hydrogen. After a few experiments in the early development of this process, the use of hydrogen was abandoned; therefore, this instrument no longer is used.

The remaining instruments are pressure indicators or recorders. Two of these operate indirectly from an air pressure transmitter which transmits air in proportion to the pressure in the tank. One reads from 0 to 760 mm total pressure, the other reads from 0 to 200 mm total pressure. The strip-chart recorder is a thermocouple gage recorder which records pressures at six different points. Thermocouple gages are used here to read pressures below those which can be measured by direct-reading instruments. This type of instrument reads pressures indirectly by measuring the thermal conductivity of a gas surrounding the pressure sensing element. (Gases at high pressure will conduct heat away from a heated thermocouple faster than gases at low pressure.) The instrument is calibrated using dry air and it reads accurately only under these conditions. In vacuum melting the pressure over the melt is due to gases which contain hydrogen, nitrogen, carbon monoxide, carbon dioxide and water vapor. Hence, the readings on any pressure measuring instrument of this type are not accurate but give only relative readings.

Operator's Console

Controls within the reach of the operator (Fig. 4) permit him to open and close all vacuum valves in the system, tilt the furnace, the charge lock, raise and lower charges from the charging chamber, and rotate the turntable on which the molds are sitting.

Hot Topping

Provisions have been made in the induction melting furnace for an arc hot topping device (Fig. 5). A small drive motor moves the electrode up and down, and another motor is used to counterbalance the weight of the electrode assembly and the effect of pressure or vacuum within the tank. A third motor rotates the electrode tip around a small circle so that the molten pool on top of the ingot will be wider than if the arc remained stationary.

Instrument Problems

A mass spectrometer was bought to study the mechanism of gas evolution in the vacuum melting process. We had hoped to use this instrument to give a picture of the changes which take place in the atmosphere over the melt as the refining process proceeds; we have not accomplished this objective.

Another important field in which we still have to make considerable progress is in measuring temperatures of the molten metal as it goes from the crucible or funnel or teeming pot into the mold. The quality and soundness of the ingots cast depends on tapping temperature. The difficulties encountered with the radiation-type temperature-measuring apparatus have been mentioned. We currently measure temperature primarily by an optical pyrometer held in the hand of the operator and sighted through one of the glass ports.

The instrumentation most needed for induction vacuum melting is an efficient, dependable and accurate way for reading molten metal temperatures inside the vacuum tank. A device for making these measurements should also be one which can be used over and over again without requiring frequent service on a device which is inside the vacuum tank.

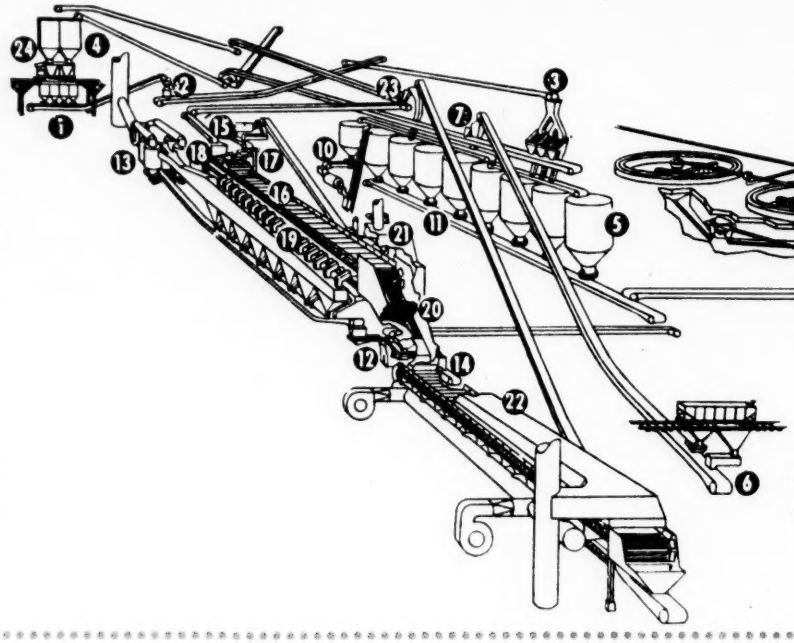

FIG. 1. STEPS IN the sintering process.

The sintering-plant operator depends on the instrumentation described here to guide his judgement, but full automatic control has not yet proved itself—for the reasons given.

Sintering-Plant

IN ORDER to make use of fine ore particles in a blast furnace it is necessary to fuse the ore dust into larger particles that will not be blown out of the furnace by the air blast. This is called sintering (Fig. 1) and is accomplished by passing air through a mixture of fine ore and fuel so that, when the fuel is burned, the ore particles are fused or agglomerated into larger masses.

Sintering Operation

Miscellaneous fine materials used in the sintering process can be flue dust (hot or pugged), coke breeze, roll scale, limestone dust and fine screened ore.

The raw materials are drawn from the storage bins (5 in Fig. 1) in proper proportion and conveyed to the primary mixing station or pugmill (12). The mix is conveyed to a secondary preparation station (15) where the material is given another mixing and a controlled amount of moisture is added (if necessary).

The prepared mix travels under the gas-fired ignition furnace that ignites the carbon on the surface of the bed. With the proper mixture of material and speed of sinter machine travel, the bed of material is completely burned through at or near the end of the suction area. (21).

The material at this final stage is sinter and discharges from the sinter machine through a sinter breaker (20) where it is broken to a size suitable for efficient cooling and handling.

Instrumentation

During the early years of sintering, instrumentation techniques suffered almost complete neglect. The plants were not pushed to optimum production and the operator's skill was the key to efficient operation.

In recent years the steel industry has proved the importance of sintering, which has expanded on a world-wide basis. Concerted efforts to achieve maximum production and controlled quality of sinter have shown instrumentation to be a necessary feature.

Large plant size and complex material handling (Fig. 1) constitute the major problems in controlling the sintering process. The operator must be able to select and maintain the desired amounts of individual raw materials, return fines, fuel and moisture, to the extent best suited for the sintering process. This control can be subdivided into two major groups—(1)

Presented at 7th Conference on Iron & Steel Instrumentation, Pittsburgh, March, 1957.

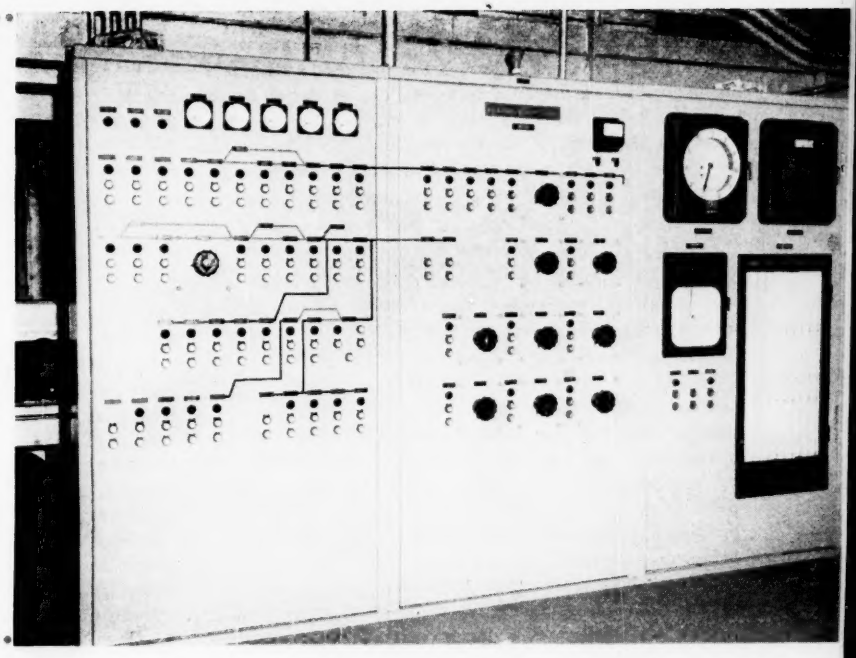

FIG. 2. THIS PANEL controls a section of the sintering plant at a Pittsburgh area steel mill. Pushbuttons in left and center sections operate equipment such as feeder tables, pug mills, sinter machine, sinter cooler and conveyors, which are represented graphically on the panel. Indicators at top left are ammeters for pug-mill and sinter-fan motors. Manometer bank at far right indicates sinter machine windbox vacuums. Top recorder and indicator is for sinter machine speeds. Lower unit records vacuum in ductwork and at main sintering fan.

Instrumentation

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factors controlling the physical characteristics of the feed to the sintering strand and (2) factors controlling the mechanical performance of the sintering machine and its auxiliaries.

Feed Characteristics

Effective feed control can be achieved by regulating:

1. The total feed rate and proportions of individual basic raw materials, such as ore, flue dust, roll scale, limestone and return sinter fines.
2. The proportion of fuel or carbon, such as coke or coal fines.
3. The amount of moisture in the mixture.
4. The mixing and conditioning of the total mix.

The material is drawn in large tonnages from large-capacity bins. The feeding and blending of these materials are on a volumetric basis using table feeders and special bin openings regulating feed to the table feeders. The table feeders have d-c motor drives that are controlled from the sinter machine control panel to speed up or slow down the group and individual feeder blend rate. This arrangement has proven to be a dependable over-all feeder for raw materials.

Gravimetric Proportioning

A new approach to this blending problem combines the volumetric system with a gravimetric system. The miscellaneous materials, such as coke fines, flue dust, limestone, etc., are fed to the sinter mix in proportion to the amount of ore fines being used. The ore is weighed on a belt scale before the miscellaneous materials are discharged into the conveyor. This scale transmits a pacing signal to all the feeders downstream. These table feeders (discharging into a belt feeder) contain a controller for feedback control of the d-c motor driving the table feeder. Provision is made on the master control panel to modify the signal transmitted to any individual feeder; thus the operator can change the percent setting for any material going into the blend.

The master panel allows the operator to control the ore feeders to obtain any desired over-all feed rate. The other materials are automatically increased or decreased and the blend should be of the proper proportion.

However, this gravimetric system met resistance because of high installation costs, unproved production benefit, requirement for additional complex oper-

ating equipment, and unknown maintenance costs. Also, a considerable tonnage of proportioned material lies on long conveyors. Thus, if the operator changes the proportioning because of conditions at the sinter machine it will be some time before the corrected mix is on the machine. As a consequence the blending usually is done via a constant adjustment made by an operator.

Moisture

Moisture content of the feed is recognized as a critical operating variable. The moisture content and its distribution determine the bed permeability which, in turn, affects the production rate of the plant.

Moisture control via an indirect technique has proved most workable so far. With the recent use of balling drums or revolving discs at the secondary mixing stage, the total addition of water is determined by the tendency of the extremely fine material to pelletize or ball. The operator adjusts water flow depending on the appearance of the feed material and performance on the sintering strand. Normally, a pressure-regulating valve provides constant water pressure to the distributing nozzle in the mixing equipment. A flowmeter indicates water flow to the mixer. Solenoid valves shut off the water flow automatically when the mixing equipment drive motor is stopped.

When the raw-material moisture content fluctuates slightly the added water can be controlled by a differential water controller. In such a system a signal from the total sinter mix weight-scale paces the addition of water to the mixing equipment. The addition of water to the sinter mix is on a gallon-per-ton basis that can be adjusted when necessary from the main control panel (Fig. 2).

Another promising, though again indirect, approach to moisture control is by measurement of *permeability* of the sinter bed. This is a measure of the porosity of the bed and is a function of bed depth, air flow and pressure differential. Measurement is by a venturi-type differential producer in a windbox downcomer pipe. This is designed to give a pressure differential of convenient magnitude for indication and recording by standard instruments. The production advantage of this system is still unproved but data from new installations soon will be available.

Machine Performance Instruments

A second group of instruments indicate the performance of the sintering strand and auxiliary equipment.

The faster the traveling grates move, the greater the production of sinter; but this speed is governed by the sintering rate—that is, the rate at which the combustion zone travels through the bed of material from ignition of the surface to the hearth layer or grates. The burning must take place during the travel from the ignition point through the suction zone (which terminates just prior to the discharge point). The rate at which material is being conveyed to the sinter machine must be balanced so that a minimum pile of material is at the machine feed.

The usual procedure is to adopt a feed rate and machine speed to allow for slight changes in the operation. The sintering machine speed is adjustable manually from the control panel by control of the d-c drive motor. The sintering machine speed is indicated and recorded by standard instruments. If the mixture, permeability and suction remain constant, the rate of burning will be constant and an optimum machine speed can be found.

The instrumentation of the ignition furnace consists of the usual instruments to control gas and air ratio and flow, complete with safety valves. Fuel consumption is recorded. A recording and indicating potentiometer for measuring surface temperature of the sinter bed immediately after ignition has not gained wide acceptance but does show promise as a measure of sinter-mix-to-fuel distribution and as an indication of the mixing efficiency.

Instruments indicate and record suction and temperature at strategic windboxes in the suction area. Vacuum and temperature indicators are used as the measures of the combustion process and these readings influence the operator's manual adjustments to the sinter mix blend. Though these instruments have proved most helpful to skilled operators, the use of the readings to control the process automatically has not yet developed.

The suction system includes the equipment and ductwork required to induce a specific amount of air through the bed of material in the sinter machine. The amount of air required and the suction resistance has been determined from years of sintering operation experience, testing, and laboratory studies. The limits of allowable air temperatures are determined by mechanical condition of the equipment. The operator maintains desired suction resistance and gas temperatures in the suction system.

It is in this combustion phase of the process that many variables can develop that destroy the balance required, but as the operation enters this phase there is little control available to the operator. If temperature and vacuum readings begin to change from those desired, an adjustment to the preparation of the raw materials is the usual correction made in anticipation of again getting the desired readings when this material reaches the burning phase. It is here that the operator's skill is required. His analysis of the instrument readings and mechanical condition of the equipment determines the mix adjustment he will make.

Electrical control and interlocking stations are located at strategic points in the plant. Each station has a panel with a flow diagram and signal lights to indicate when equipment is running. An inter-plant communication system is provided with stations at strategic locations.

No attempt is made herein to describe instrumentation being used in *laboratory studies* of the sintering process. There is continuing research in the laboratories and pilot plants in the search for knowledge and understanding of this process, out of which will come the specifications for additional and new instrumentation for the production plant. Some of the equipment and instrumentation techniques reviewed here could be adapted to advantage at various existing sinter plants for increased production, a more consistent product, and improved ease of operation.

Higher blast temperatures and blast rates are becoming more difficult to meet with slow, manual stove changing. Pushbutton-controlled power actuators can change stoves in five minutes.

FIG. 1. EACH BLAST FURNACE (center) has several stoves (in line at left of furnace) for preheating air blast.

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Automatic Stove Changing for Blast Furnaces

A BLAST FURNACE is customarily provided with several hot blast stoves (Fig. 1), one of which is heating the cold blast for the furnace while the others are being heated by burning blast-furnace gas. The stoves are filled with a checker-work of refractory brick. When a stove is heated sufficiently, various valves are closed and others opened so that the hot furnace gas is cut off from the stove and cold blast passed through it. This cold blast is heated by the hot refractory checker-work and delivered to the blast furnace.

Each hot blast stove is normally provided with two chimney valves, a burner shut-off valve,* a burner gas valve, a cold-blast valve, a hot-blast valve, a blow-off valve, and a Vincent mixer selector valve.

*Usually a cumbersome trolley-suspended disc, secured with heavy yoke and bolting arrangement.

Presented at Seventh Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March, 1957.

Manual Stove Changing

At least 15 minutes, and often 20 minutes, are required to change stoves manually. This time must be deducted from the gross gas period. If the gross gas period is 4 hours, the deductable 20-minute change time is only about 8%—but if the gross period is, say 2 hours, the deductable 20-minute change time becomes a serious 17%. Limitation in combustion-chamber size and checker heating area frequently render it impossible to compensate for such time losses simply by increasing the gas firing rate.

The use of power-actuated valves greatly shortens the stove-changing time and makes available the use of shorter blast periods for sustaining higher blast temperature at higher blast rates.

If the cumbersome stove door is replaced with a burner shut-off valve, and if all valves are equipped with power actuators, 10 to 15 minutes can be saved in stove-changing time.

In order to shorten the stove-changing time and secure higher blast duty from existing stoves, the following three steps should be considered. They are listed in order of relative importance:

1. Replace conventional stove door with a burner shut-off valve.
2. Install power actuators on the larger valves or valves that are difficult to operate manually.
3. Install an automatic stove-changing system.

Two valves that should be considered first for power actuators are the cold-blast valve and the hot-blast valve. The mushroom-type hot-blast valve has a travel of from 7′ to about 12′ and is difficult to operate at times.

In addition to the time that can be saved by putting power actuators on the hot-blast valves and cold-blast valves, interlocking can be applied with little added cost. It is a costly mistake if all the stoves are inadvertently taken off the furnace at one time and the blast-pressure at the tuyeres drops to zero. To prevent this it is necessary to have two stoves ON BLAST before taking a stove OFF BLAST. The cold-blast valve is the first valve to be closed when taking a stove OFF BLAST, therefore interlocking should be provided so that a hot-blast valve on one of the other stoves is open before the cold-blast valve can be closed. This is possible with remotely controlled power actuators and position limit switches.

Actuators

The types of actuators that can be used are pneumatic cylinder actuators, electric motor actuators, and hydraulic cylinder actuators.

The pneumatic power actuator consists of an air cylinder with a rack extended on the piston rod, engaging with a pinion on the valve shaft or with a pinion on an intermediate gear unit. On valves such as the gas burner shut-off valve (Fig. 2), gas shut-off valve, cold-blast valve, Vincent mixer valve, and right-angle-type chimney valves (where the operating shaft turns less than 130°), the pinion can be mounted on the valve shaft. Where several turns of the valve shaft are required for full travel (such as on the blow-off valve), or where the linear travel is several feet (such as on the mushroom-type of hot-blast valve), it is desirable to put a gear reduction unit between the cylinder and valve. In these cases a shorter-stroke cylinder can be used.

The power output of each cylinder is calculated so as not to over-power and break the valve in the event the valve becomes jammed.

Special precaution must be taken with the cold-blast valve. This valve is the first one opened when putting a stove ON BLAST and there is possibly a 25-psi pressure differential across the valve. The first action when opening the cold-blast valve opens a small port in the disc of the valve. The air in the cold blast main enters the stove through this port and gradually equalizes the pressure across the cold-blast valves. With a low differential-pressure across the valve, the main valve can be opened. The cylinder on the cold-blast valve actuator must be sized so that the valve cannot be opened while too much differential-pressure exists, which might score the seating surface of the valve.

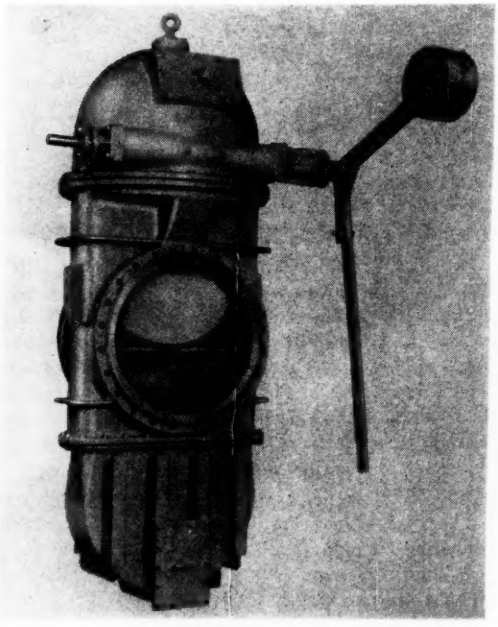

FIG. 2. FREYN-JANSEN BURNER shut-off valve has trolley-suspended disc that drops to seal (and raises to open) gas passage. Disc is shown partly raised; weight holds valve either open or closed. Pneumatic actuator can be used to drive rack engaging a pinion mounted on shaft at upper left.

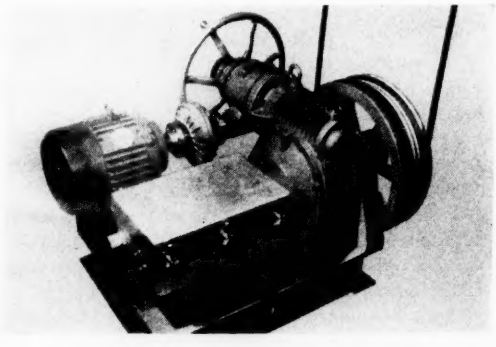

FIG. 3. HOT-BLAST VALVE ACTUATOR comprises a two-speed motor driving the high-speed shaft of a double reduction gear unit through a fluid coupling. Drum is mounted on the low-speed shaft. One cable on the drum is fastened to the vertical stem of the valve, a second cable is fastened to a counterweight so that the valve and weight are in balance.

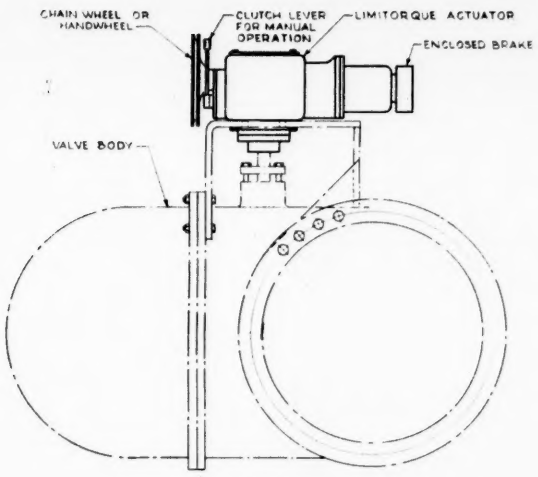

FIG. 4. A LIMITORQUE ACTUATOR is used on the cold-blast valve. Similar actuators are used on the Vincent mixer selector valve, gas shut-off valve, and blow-off valve. Torque switch in the unit automatically interrupts the motor circuit if exceptional torque is applied. Handwheel or chainwheel is provided for manual operation.

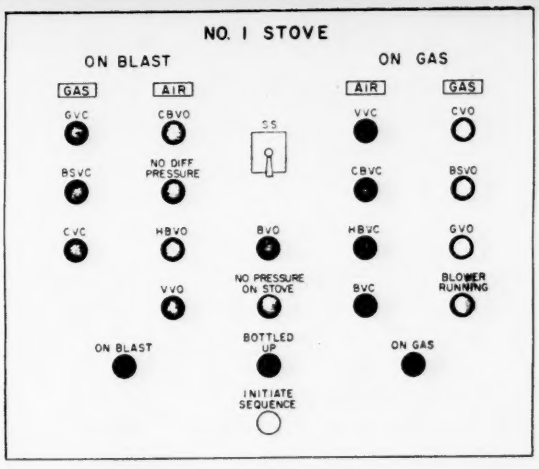

FIG. 5. MASTER PANEL FOR each stove is similar in design for either the pneumatic or electric system. The indicating lights are arranged in four vertical rows to correspond with valve sequence.

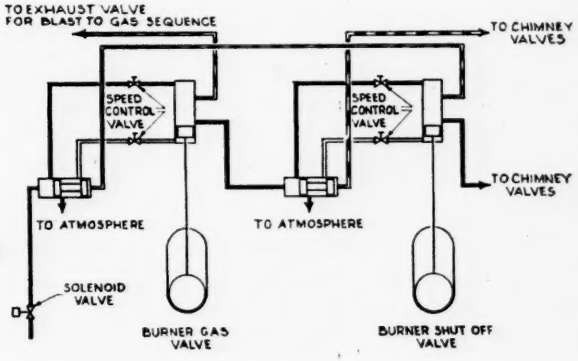

FIG. 6. PNEUMATIC SEQUENCE CONTROL diagram. The inlets at either end of the cylinder are each provided with a speed control valve so that different piston travel speeds can be had in each direction. As the cylinders are all operated in series, individual speed control is possible for each piston.

Electric Motor Actuators

Two different basic designs are used for the electric-motor actuators—(1) a fluid-coupling drive that is used for the hot-blast valve (Fig. 3), burner shut-off valve, and chimney valves, and (2) a Limitorque drive (Fig. 4) for the remaining valves.

The fluid coupling has the following advantages:

1. Permits the motor to approach synchronous speed before applying the full load.

2. If the valve should stick when moving to the closed position, the coupling will not develop sufficient torque to overhaul the counterweight and develop slack cable.

3. With the motor operating at half speed near the end of travel, the coupling slip increases rapidly and the valve is not banged down on the seat.

4. Permits the valve to be driven onto the seat before the motor-circuit is opened.

Hydraulic actuators are used in a manner similar to the pneumatic devices already described.

Sequencing and Interlocking

Four possible selections of a sequence of operation are possible with automatic stove changing control:

1. *On gas from blast*—where the air valves are closed and the gas valves opened and the burner blower started.

2. *On blast from gas*—where the gas valves are all closed, the blower stopped, and the air valves opened.

3. *Bottle-up from gas*—where the gas valves are all closed, except the blow-off valve, and the blower stopped.

4. *Bottle-up from blast*—where all the air valves are closed and the blow-off valve opened. The selection of the various sequences is made through a selector switch on the master panel (Fig. 5).

Pneumatic sequencing is accomplished by connecting all of the operating cylinders in series to one air supply (Fig. 6).

Motor Interlocking

A different type of interlocking must be used with the electric-motor-driven actuators. Limit switches on each actuator not only limit the motor travel and light position-indicating lights but also provide the interlocking between the valves to assure proper sequencing.

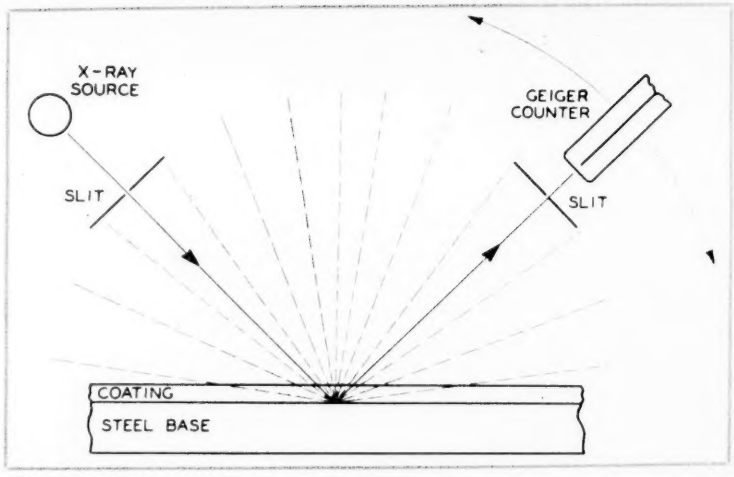

FIG. 1. CERTAIN X-RAYS GENERATE fluorescence in iron that is radiated in all directions. A coating, such as tin, partially absorbs this radiation. A detector, in this case a geiger counter, measures the amount of fluorescence that escapes from the coating. The detector output can be calibrated in terms of coating weight.

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X-Ray Tin Thickness Gage

This non-contacting x-ray tin thickness gage measures x-ray fluorescence of iron to give a continuous record of tin coating weight to a precision of ±0.01 lb of tin per base box.

MEASURING the thickness of a coating of tin on a steel base is complicated by the fact that the base metal thickness normally varies more than 100 times the thickness of the coating itself. A piece of tin plate with a nominal thickness of 0.008" will vary in thickness as much as ±0.001"; the layer of tin covering the plate is only 0.000015" thick (0.25 lb per base box). This large ratio of steel tolerance to tin thickness makes total thickness measurements (base plus coating) futile as a means of measuring the amount of tin coating.

Industry has relied on chemical methods of tin determination for plating control. The chemical method is slow and destroys the sheet being tested. Chemical coating-thickness determination limits the value of the results to principally a post-mortem check of the material produced and the line operator must rely on indirect factors such as line speed, plating current, solution temperature, etc., as an immediate guide. In short, it is a high-cost, relatively unsatisfactory method of production control, and with tin selling as high as $1.37 per lb, and with an annual tin consumption by the tin-plate industry of approximately 32,000,000 lb, there is pressure to conserve tin.

Modern electrolytic tinning lines that operate at speeds as high as 2000 fpm emphasize the need of continuous supervision of the plating operation.

Presented at Seventh Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March, 1957.

Iron Fluorescence

This method makes use of iron fluorescence (Fig. 1). An x-ray beam from a copper target strikes a sheet of tin plate, penetrating through the tin into the base metal. The x-ray beam causes iron to fluoresce, giving off characteristic iron radiation.

As the iron fluorescence leaves the steel sheet, it is partially absorbed in the tin coating so that the amount received by a radiation detector decreases with increase in tin thickness.

Although the direct-reading x-ray spectrometer is an excellent piece of laboratory equipment, it has several limitations as a mill control instrument, hence a null-balance instrument was developed for plant use.

Design of the Null-Balance Gage

Accuracy should not be dependent on the stability of the x-ray source and detector. This can be accomplished by using the gage only as a comparator and matching the signal from the unknown tin plate with that from samples of known coating weight. When identical readings are obtained, the coating weight of the unknown will be the same as the standard. The new gage makes the comparison automatically and rapidly (30 times per second) so that drift of measuring components has little effect on the instrument accuracy. Because of its unique design, only one standard sample is needed, and this is positioned automatically.

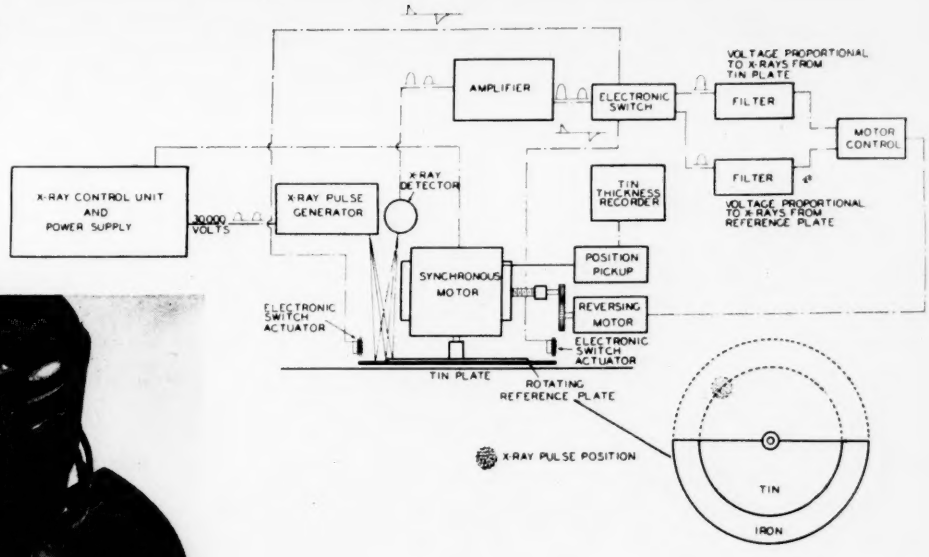

FIG. 2. BLOCK DIAGRAM of the major components of the final gage employing the null-balance design.

FIG. 3. THE STANDARD IS ROTATED by a synchronous drive motor. The large semi-circular disk is iron; the smaller semicircular section is a tin coating. The entire assembly is moved back and forth to expose more or less uncoated iron to the x-ray beam to effect a balance between the emission signal from the moving strip and that from this standard.

Gage Operation

Fig. 2 is a block diagram of the gage as now constructed. The x-ray source is the same as was used in the experimental model, and produces 60 x-ray pulses per sec with a pulse duration of somewhat less than 1/120 sec. The photomultiplier-type x-ray detector uses a type-B fluorescent screen as the means of transforming the x-ray energy to visible light.

The standard (Fig. 3) is a semicircular plate, a portion of which is coated with a tin coating of sufficient thickness to absorb all flourescent energy. The plate is rotated at a speed of 30 rps by a synchronous motor, and also is moved laterally by a reversing motor, as shown in Fig. 2.

On one pulse, the beam strikes only the strip; on the next pulse the beam strikes the standard owing to the rotation of the standard. The plate then is moved laterally so that the portion of the beam area falling on the uncoated portion of the standard gives a signal equal to that received from the strip. By proper choice of position of the rotation axis of the plate, the radiation from the plate can be made equal to that from any given sample of tin plate. The behavior of this standard is identical to one with a wedge-type coating.

The signals from both the standard and tin-plate sample are amplified and then separated in the electronic switch (Fig. 2). The electronic switch also acts as a discriminator rectifier so that two d-c potentials are obtained from its output; one corresponds to the intensity of radiation from the standard and the other to the intensity from the moving strip. These two potentials then are filtered separately and fed to the differential motor control that actuates the reversible motor that moves the standard in the proper direction to maintain equal d-c potentials from the discriminator.

In order that the discriminator shall differentiate between pulses from the strip and those from the standard, magnetic pickups located close to the edge of the rotating standard sense the angular position of the standard and initiate the switching action of the discriminator.

Performance

The prototype continuous gaging unit has been in 24-hr operation since 1951 and gives every indication of being an entirely practical unit for mill control. The instrument is accurate to approximately 1% of full-scale reading and will maintain this accuracy over extended periods. As a precautionary step, the gage is checked once each 24 hours, using a standardized sample of tin plate. However, calibration adjustments are seldom needed.

The production of standard samples for checking the x-ray gage has posed somewhat of a problem. Chemical methods do not appear to have the precision of the x-ray method and are destructive; the plating area actually checked by chemical means is no longer available for use as a standard. By sorting similar samples with the x-ray unit and then checking part of these chemically, a series of standards was developed. In this work the A.I.S.I. Referee chemical method gave the most reproducible results.

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1. H. F. Beeghly, "An X-Ray Method for Determining Tin Coating Thickness on Steel," *Journal of the Electrochemical Society*, vol. 97, no. 4, April, 1950. (U. S. Patent No. 2,521,772.)

2. G. E. Pellissier and E. E. Wicker, "X-Ray Tin Coating Gage," *Electrical Manufacturing*, May, 1952.

Continuous Galvanizing Instrumentation

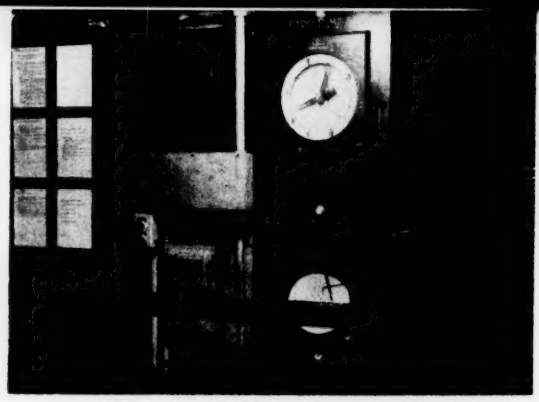


FIG. 1. OXIDIZING furnace panel.

The success of the Sendzimir continuous galvanizing operation depends on precise and consistent control of the several variables involved. This report on the lines at Ashland, Kentucky, shows the application of fundamental instrumentation practices.

WALTER E. HAND

Armco Steel Corporation

SENDZIMIR process for continuous galvanizing of mild steel strip was begun commercially at the Armco Steel Corporation, Butler (Pa.) Works in 1936. Since that time galvanizing units employing the process have been erected in Armco plants at Middletown (Ohio) and Ashland (Kentucky). This process has revolutionized the strip and sheet galvanizing industry in a manner comparable to the effect of the continuous rolling process on the sheet rolling industry.

The principal features of the operation at Ashland consist of heating and cooling the strip in prescribed atmospheres at designated points, and finally immersing the strip at the proper temperature in the alloyed zinc bath.

Surface preparation of the base metal is the first step in the operation. This is accomplished in two steps—oxidation of the strip surface, then reduction of the oxide. For reasons of economy each of these steps are combined with other essential functions. The oxidizing operation, performed in a short furnace equipped with an adjustable firing pattern of high-temperature, direct-firing burners, serves also to clean the surface of remnants of rolling lubricants and other combustible material.

The reduction of the oxidized surface, following immediately, also incorporates provision for annealing the strip. This is done in a furnace of suitable length in which the heat is furnished by natural-gas-fired radiant-tube burners. The furnace must be practically gas-tight to contain the reducing atmosphere, which is composed of dissociated ammonia.

The end of the cooling chamber is turned downward and extends into the molten metal of the coating pot so that the reduced strip surface is protected up to immersion in the coating bath.

Oxidizing-Furnace Instrumentation

A recording pressure-controller* controls the burners on the oxidizing furnace. The operator selects a burner pattern consistent with the width of the strip being processed by opening or closing valves to individual burners or groups of burners. He then selects a burner pressure within the allowed range and sets the control index on the pressure controller to that value. Further adjustment of the pressure control index is made as the need is indicated by the record of the temperature of the strip leaving the furnace. This record is provided on a round-chart "Electronik" pyrometer (Fig. 1) operating from a "Radiamatic" temperature detecting unit, exposed to the top of the strip (Fig. 2) between the oxidizing and reducing furnaces. An additional indicator is wired in parallel with the temperature recorder and mounted at a position convenient to the station of the line operator to keep him informed continually of the strip temperature from this furnace.

The pressure controller operates pneumatically, with throttling and reset response. Valves are actuated in both gas and air lines ahead of the point at which the two are mixed. Control at this furnace is based on fuel pressure rather than directly on temperature because of the limited turn-down permitted by pre-mixing fuel and air. Some thought has been given to a scheme by which the pressure controller index would be automatically adjusted, within limits, from temperature indications.

Presented at 7th Annual Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March, 1957.

*Minneapolis-Honeywell Regulator Co.

FIG. 2. " RADIAMATIC" MOUNTED over oxidized strip.

FIG. 3. MAIN FURNACE AND POT CONTROL panel. The high-limit instruments are not on this panel, being located closer to the furnace.

Reducing-Furnace Instrumentation

The reducing furnace has been divided into four zones for purposes of control. Temperature of each zone is detected by a Radiamatic unit sighting into a closed-end tube which is mounted in the roof of the furnace. The closed end of the tubes extends to within a few inches of the strip pass line so the influence of strip temperature on the indicated zone temperature is considerable. A round-chart recorder-controller, with both throttling and reset responses, serves each zone. Control is effected primarily by regulation of the combustion air flow to each zone through a pneumatically operated North American valve. Gas is regulated by proportioning it to air flow.

A complete auxiliary system is provided for supervisory, or limit, control on each zone. A second Radiamatic detector is mounted in the roof of each zone, with the end of its closed-end sighting tube at a little greater distance from the strip than that of its companion, making it somewhat more responsive to furnace than to strip temperature. The round-chart recorder-controller is provided with high-temperature-limit contacts connected to electropneumatic relays that can cut off the air supply and bleed the line to the control valve positioner. A series gas valve, normally held open by pressure from this same supply air also is shut off in the same event, which may be electrical panel supply failure as well as actuation of the high-limit control.

Cooling

The controlled cooling sections of the furnace are divided into three zones for purposes of control. Cooling is accomplished by heat-exchanger tubes that are cooled by fan-propelled air. The amount of air furnished each zone is governed by the relationship of the temperature of the zone to the corresponding set point and is accomplished through pneumatic operation of a valve in the cooling air supply. The controller has both throttling and reset response.

Cooling zone temperatures (a composite of strip and furnace temperatures) are detected by thermocouples brought through the roof of the furnace at its centerline. Round-chart recording-controlling pyrometers actuate the controls.

Electric heaters provide heat in the cooling zones if needed. These heaters are cut in by a "Pressuretrol" type of pneumatic-electric relay that operates when the pressure in the cooling-air circuit indicates that the cooling air is off completely.

Bath Instrumentation

A thermocouple immersed in the melt records on a round-chart recording pyrometer.

Temperature of the pit furnace surrounding the pot, which is used mainly for warm-ups and periods of extended delays, is detected by a thermocouple and recorded and controlled by a round-chart recording-controlling pyrometer. The temperature chosen by the operator is set on the control index.

Auxiliary Control Instrumentation

The main panel (Fig. 3) carries a selector switch and an auxiliary recorder-controller. This instrument can be connected to protected thermocouples paralleling each of the Radiamatic installations to check any temperature in the system. This is also a controlling instrument and can be used to furnish emergency or temporary control at any point by making relatively simple changes in the pneumatic control circuits.

Strip Speed Instrumentation

Strip speed is recorded by an Esterline-Angus tachometer.

The electric heating units of the ammonia dissociators are controlled by indicating-controlling pyrometers operating from thermocouples in the units.

Auxiliary instrumentation on the operating consoles comprises simple indicating tachometers, loop-car position indicators, and various ammeters and voltmeters indicating motor and heater loads, etc.

The control system succeeds only under the condition that the speed of the strip be maintained carefully within the range for which the unit was engineered. However, within this range the principal critical variables are under such control that a product of uniform high quality is produced.

Edge-position of moving strip can be controlled by mechanical guides, contact rollers, self-centering rolls, photoelectric noncontact systems, and pneumatic-hydraulic noncontact systems.

FRANK J. MARKEY
Askania Regulator Co.

Edge Position Control

THE EDGE-POSITION CONTROL shown in Fig. 1 is a typical pay-off reel application installed ahead of a slitter or side trimmer. The amount the actual strip position is offset from the required strip position is the "strip positional error" or "strip error."

Self-Centering Rolls

Self-centering rolls (Fig. 2) depend on constant tension of the strip to guide effectively. It is not practical to use self-centering rolls on the entry end of the process line if the coils on the pay-off reel are telescoped.

Mechanical Side Guides

Mechanical side guides are rollers (Fig. 3) that force the strip to the desired path. In most cases it is necessary to have a looping pit ahead of the side guides and the strip brought up slack in order to prevent damage to the edge. Also, it is difficult to run "telescoped" coils (owing to drift of centerline during windup) at high speeds. Therefore, speed of such a line is comparatively low.

Contact Rollers

A roller can be used to trip an electric or pneumatic switch when engaged by the strip (Fig. 4). This switch causes a motor to drive a pivot roll in one direction or the other. The contact roller is located immediately outside of the usual strip pass line. This is considered an "on-off" control because the correcting roll over which the strip passes is moved into one or the other of two fixed positions.

This system is not satisfactory for high-speed process lines because there is a considerable time lag before the strip responds to movement of the pivot roll and makes the strip wander back and forth continuously. However, an advantage over the mechanical side guide is that the engagement of the strip with the contact roller is light: there is less likelihood for damage to the edge of the strip.

Photoelectric Noncontact Systems

Photoelectric noncontact edge-guiding systems can be divided into two classes:

A. On-off control (Fig. 5) employs two light beams with a neutral zone between them. Normally, one beam is covered by the strip and the other uncovered. If both are either covered or uncovered, an electric motor drives the reel to move the strip to uncover or cover the appropriate light beam. This correction occurs at constant speed.

Presented at 7th Iron & Steel Instrumentation Conference, Pittsburgh, March, 1957.

FIG. 1. BASIC position control system.

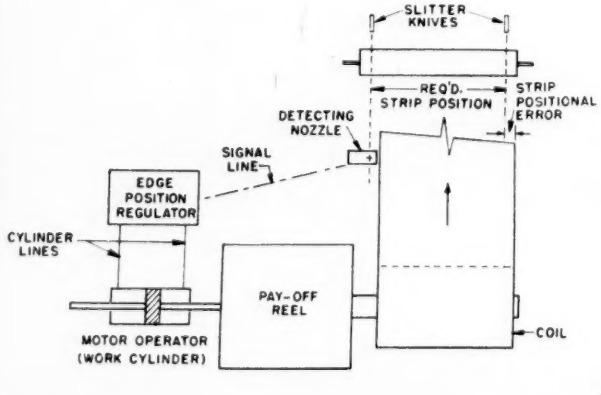


FIG. 2. CENTERING ROLL.

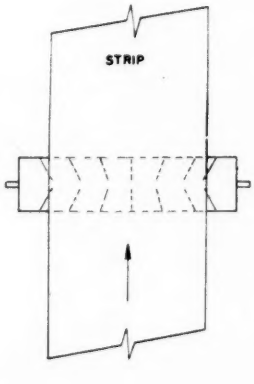
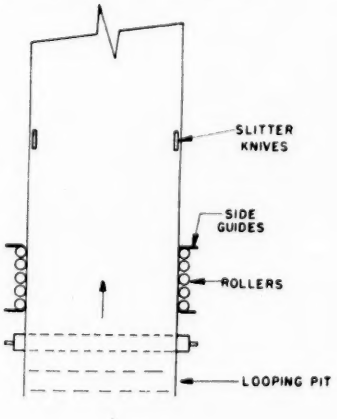


FIG. 3. SIDE GUIDES.



B. Floating control (Fig. 6) is more complex than the two-position control. The detector senses the amount of light received from a single light source. The *rate* of correction of the operator is proportional to the *magnitude* of strip positional error. The system can be adjusted so that little dead zone exists; hence, the strip is under continuous control.

Electric noncontact systems have a decided advantage over all others mentioned previously because there is no contact with the strip edge and, consequently, no damage. The on-off control is economical for a slow-moving process line: the floating control is more satisfactory for high-speed lines because the rate of correction decreases as the strip approaches the required strip position. This avoids hunting.

Pneumatic-Hydraulic Noncontact System

Fig. 7 shows a system that uses a pneumatic edge-position detector and a hydraulic correcting motor operator.

This is similar to floating electric scanning in that the *rate* of correction of the motor operator is proportional to strip positional error.

The pneumatic-hydraulic control system shown in Fig. 7 comprises three main units—(1) the air-pressure detecting nozzle, (2) the edge-position regulator, including the hydraulic power unit (pump unit), and (3) the hydraulic control cylinder (operator).

The *air pressure detecting nozzle* senses the strip edge position continuously. The nozzle consists of two facing slotted orifices: one is the "supply orifice" and the other the "recovery orifice."

The receiving orifice develops a pressure of 4" W. C. when the supply orifice is completely uncovered, and zero pressure when covered. A $\frac{1}{2}$" motion of the strip will cover the supply orifice completely.

The jet pipe, through the diaphragm system, responds to pressure signal changes received from the air-pressure detecting nozzle, and the direction of movement depends on whether the pressure signal is greater or less than the spring force.

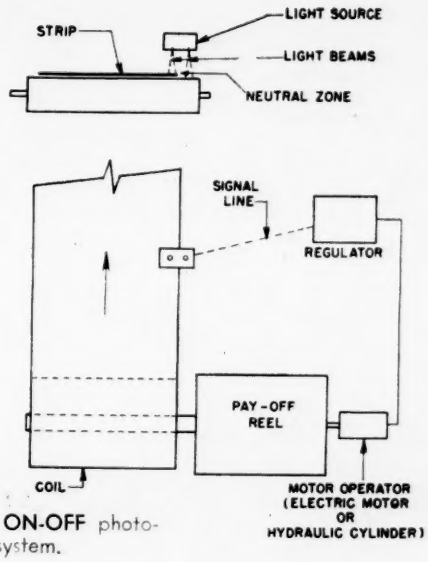


FIG. 5. ON-OFF photo-electric system.

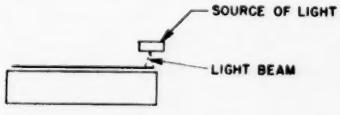
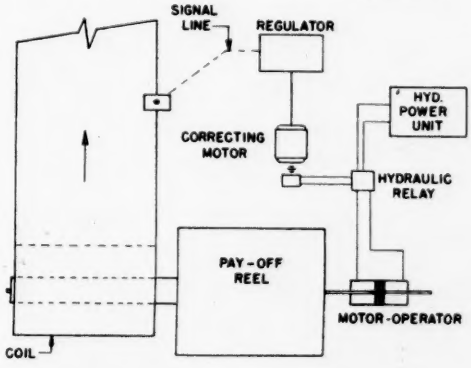


FIG. 6. FLOATING photo-electric control.



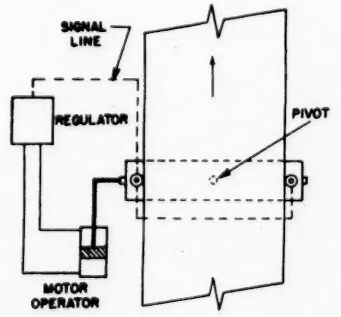
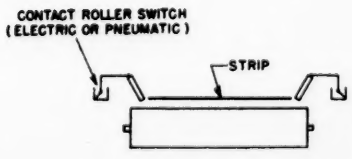


FIG. 4. CONTACT roller switch system.



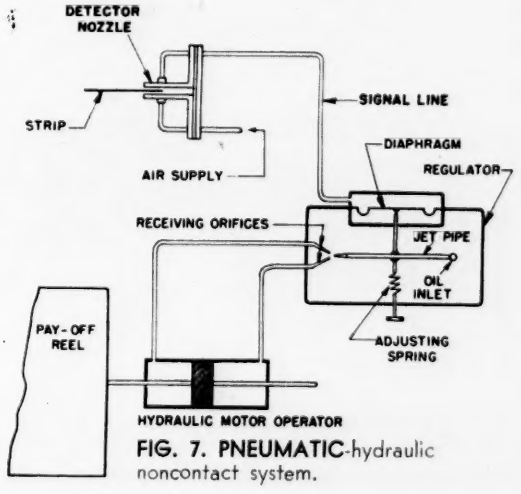


FIG. 7. PNEUMATIC-hydraulic noncontact system.

FIG. 1. TELEVISION TEST equipment used in this program.

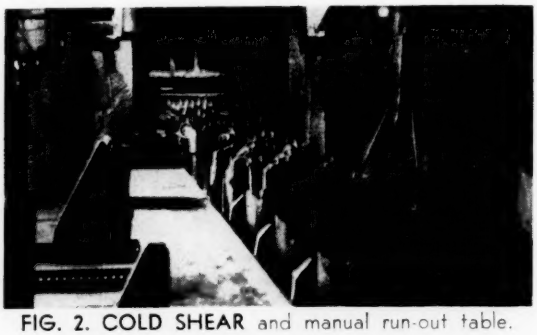


FIG. 2. COLD SHEAR and manual run-out table.

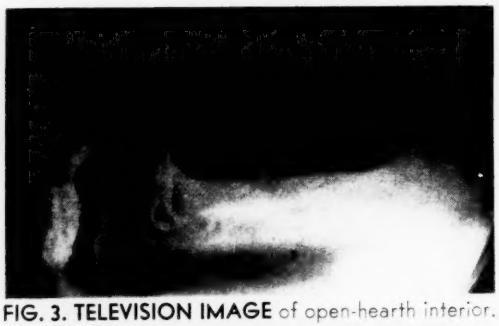


FIG. 3. TELEVISION IMAGE of open-hearth interior.

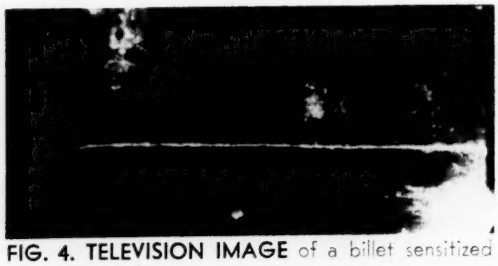


FIG. 4. TELEVISION IMAGE of a billet sensitized with Magnaglo.

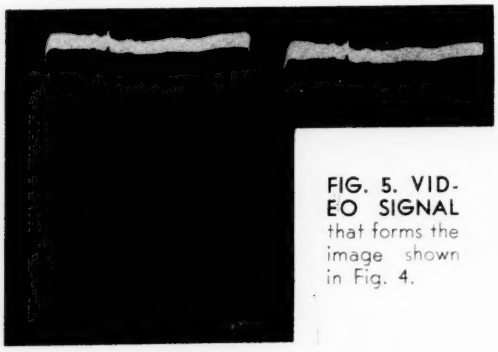


FIG. 5. VIDEO SIGNAL that forms the image shown in Fig. 4.

Closed-Circuit Television in the Steel Industry

GEORGE DYKEMAN, United States Steel Corporation

UNITED STATES STEEL Applied Research Laboratory has been investigating possible applications of closed-circuit television in various operations of the corporation. A complete closed-circuit television system was purchased (Fig. 1) and a program of field trials planned to evaluate television in various phases of steel processing.

Ingot Stripping

One of the first trials was conducted at a central ingot-stripping yard which is a focal point of attention for people at three remote locations—(1) the railroad dispatcher is interested in knowing where a string of ingots has been stripped of the molds so that he can send an engine to move the stripped ingots to the soaking pits, (2) the soaking-pit operator needs to know when the ingots will arrive so that he can prepare for them, (3) a clerk in the production-planning office is interested in knowing the location of individual ingots.

A television camera was placed at one corner of the stripping-yard roof to obtain a view of the entire yard and a monitor unit was placed at each of the three viewing stations.

Shearing Operation

The cold-shear operator must be sure that the exit end of the shear is clear of people (Fig. 2) before allowing more material to pass through. To insure maximum safety of workers in the area a television camera was mounted away from the exit end of the shear and a monitor placed where it could be seen by the operator at his normal operating position. The television equipment proved successful in improving safety procedures.

Sintering Plant

Two cameras and one monitor were installed at a sintering plant so that the operator could observe alternately, from his control panel, two remote conditions that are essential to sinter production. One condition is the appearance of the sinter as it is discharged from the moving grate. This picture informs the operator whether the machine is moving at optimum speed and whether the raw materials are being mixed uniformly. A second condition is the level in the sinter cooler outside the sintering plant where

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Presented at 7th Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March, 1957.

the hot sinter is cooled before being transferred to the blast furnaces. Remote observation of these conditions at the control panel means that the operator will not have to leave the control panel to obtain this necessary information, and better control of the sintering operation can be expected.

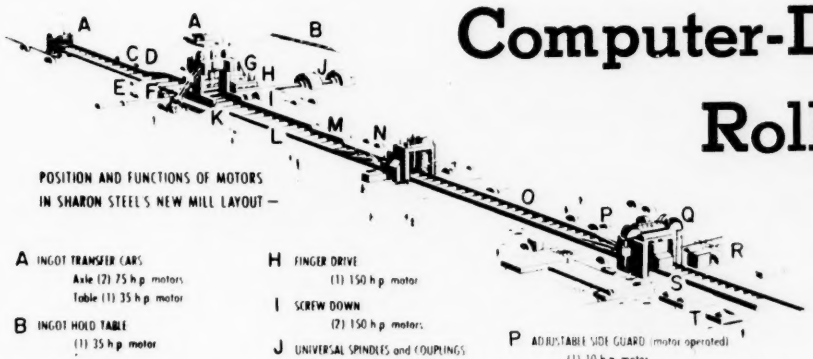
Open Hearth

Combustion studies have been conducted at three plants to assist in evaluating open-hearth procedures. A television camera is mounted on each end of an open hearth so that either end of the furnace can be viewed from a single large-screen monitor located near the operator's control panel (Fig. 3).

Inspection

Objects can be inspected and irregularities and defects can be counted or indicated on a meter that receives the video signals from the camera. For example, Fig. 4 is a television image of a billet sensitized with Magnaglo material. Note that a seam in the billet is revealed as a white line. Fig. 5 shows the oscillograph trace of the video signal, which can be used to operate an automatic rejecting mechanism.

Computer-Designed Rolling Mill



POSITION AND FUNCTIONS OF MOTORS IN SHARON STEEL'S NEW MILL LAYOUT —

A INGOT TRANSFER CARS
Axle (2) 75 h.p. motors
Table (1) 35 h.p. motor

B INGOT HOLD TABLE
(1) 35 h.p. motor

C RECEIVING TABLE
(1) 75 h.p. motor

D MILL APPROACH TABLE
(1) 75 h.p. motor

E MILL RUN IN TABLE
(1) 100 h.p. motor

F FRONT and BACK MILL TABLE
1-4 rolls (4) 75 h.p. motors
5-14 rolls (4) 75 h.p. motors

G MANIPULATOR DRIVE
(4) 150 h.p. motors

H FINGER DRIVE
(1) 150 h.p. motor

I SCREW DOWN
(2) 150 h.p. motors

J UNIVERSAL SPINDLES and COUPLINGS
(2) 4000 h.p. motors

K FEED ROLLS
(4) 150 h.p. motors

L MILL RUN OUT TABLE
(1) 100 h.p. motor

M SCARFER APPROACH TABLE
(1) 75 h.p. motor

N SCARFER DELIVERY TABLE
(1) 75 h.p. motor

O SHEAR APPROACH TABLE
(1) 75 h.p. motor

P ADJUSTABLE SIDE GUARD (motor operated)
(1) 10 h.p. motor

Q SHEAR and DRIVE
(2) 500 h.p. motors

R SHEAR GAUGE
Travel (1) 35 h.p. motor
Lift (1) 75 h.p. motor

S SHEAR PULL BACK TABLE
Table (1) 50 h.p. motor
Side Guard (1) 7½ h.p. motor
Shifter (1) 15 h.p. motor

T SHEAR GAUGE TABLE
(1) 50 h.p. motor

MORE than one hundred motors, ranging from 7½ to 4,000 hp, develop a total of 12,000 hp to drive this new $14-million slabbing and blooming mill at Sharon Steel Corporation's Roemer Works (Farrell, Pa.).

A year before the mill was completed (Feb. 1957), a study was made to determine the power system necessary to achieve maximum utilization of equipment and to reduce rolling time. The study, conducted by General Electric Company, was a "first" for the steel industry—Sharon's was the first mill designed on an electric computer.

Simulating the various forces to be encountered at each step in the rolling process, G.E. engineers used hundreds of circuit combinations and fed the data into an analog computer. In a single day the computer digested the statistics and produced charts which were converted into electrical design factors used to specify the most efficient electric motors and control instruments.

An important outcome of the project was the development of an improved control system which reduces reversing time on two huge 4000-hp motors to 1½ seconds, a 25% improvement over former reversing time. Rolls are reversed 15 to 20 times in processing each slab; the reduced rolling time represents a significant gain in efficiency when projected on a yearly rolling basis.

A further efficiency resulting from electronic design of the mill is the saving in "tune-up" time. Usually a tryout period of seven to ten days is required to synchronize the various motors and control equipment. "Tune-up" time at Sharon was reduced to one day.

Since the new mill began operating (last February) ingot rolling capacity at the Roemer Works has been increased by one-third—to 1,200,000 tons a year. The mill can roll slabs up to 10" thick by 48" wide by 30' long and can now process stainless and high-alloy steels for the first time.

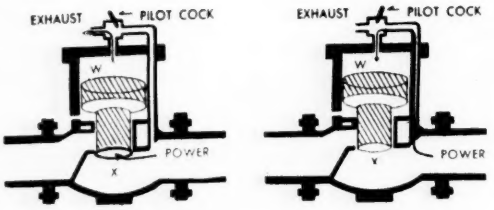


FIG. 1. OPENING (left) and closing (right) valve actions.

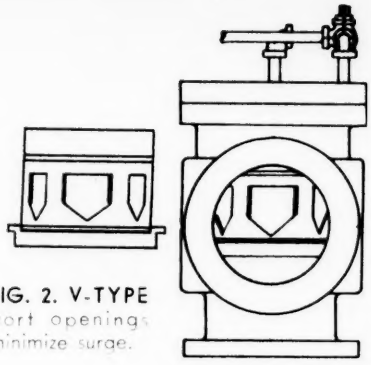


FIG. 2. V-TYPE port openings minimize surge.

Steel Mill Self-Operating Valves

G. A. COLTON

Golden-Anderson Valve Specialty Co.

Steel mills require immense quantities of water for fire protection, cooling, quenching, scaling, spraying, cleaning, and numerous other purposes. Hydraulic-piston self-operated valves are particularly applicable to steel industry requirements.

THE HYDRAULIC-PISTON valve shown in Fig. 1 uses the line pressure to operate a differential (or "unbalanced") piston in which the area W of the larger piston equals twice the area X of the small piston. As opening force is P (X), and as closing force is P (W−X) = P (X), it is seen that the opening and closing forces are equal. As the ring area (W−X) is exposed to atmosphere it provides air cushioning when the valve closes.

Upstream pressure is connected either internally (by casting a connection into the body), or externally (by using pipes) to a three-way valve. This valve either permits the line pressure to reach the top of the large piston (area W) for closing the valve, or exhausts the accumulated fluid from the top, thus permitting line pressure on the bottom of the small piston (area X) to open the valve.

The stroke of the piston is D/4 in order to provide full pipeline opening. Thus the stroke of a 6" valve for full-seat-area opening is 1½", plus an allowance for obstruction of flow through the column area from V-port openings or guides.

Flow Characteristic

Various flow characteristics can be obtained by varying the shape of either the bottom of the piston or the openings in the guide of the stem through which the piston stem passes. As general practice, the V-type opening in the cylinder line (Fig. 2) is used to permit fast closing of the valve with maximum protection against surge or hammer. When using the V-type orifice for discharge, the valve *closes* off about 60% of its orifice with ½ of its down stroke (a gate valve is about 60% *open* when ½ way through its stroke).

This reduction of orifice discharge area when the piston approaches its seat minimizes surge or hammer. This, combined with the effective air cushioning of the top exhaust, prevents slam or hammer.

Surge-Relief Valve

Fig. 3 shows a cushioned surge relief valve used to protect water lines against excessive pressures caused by surges in the system, such as those sometimes created by hydraulic equipment in the plant or by a non-cushioned fast-closing valve. It is available in either globe or angle body (illustrated) pattern. This sensitive valve opens immediately when the upstream or inlet pressure exceeds the adjustment of the pilot valve. The pilot valve is set at the factory for the service conditions specified by the customer, but field adjustment can be made.

Check-Valve

Fig. 4 shows an electric check valve. It prevents surge on check valve service by:

(1) Opening only when pump comes up to speed.

(2) Closing automatically with pump running, and shutting down pump when 95% closed.

Presented at 7th Annual Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March, 1957.

(3) Providing cushioned emergency closing in event of power outage.

When the operator pushes the start button, the pump starter and the time-delay relay in the line to the pilot solenoid coil are energized simultaneously. When the pump comes up to speed, the 3-way solenoid pilot permits the valve to open slowly at a speed determined by the adjustment of the needle regulating valve exhausting water from the top of the main valve piston. When the valve piston is at the top of its stroke (valve fully opened) the indicator rod on the valve closes the contacts on a limit switch mounted on the valve lid. This interlocks the switch with the pump motor starter and the solenoid pilot. Thus, when the valve is full open the pump is in operation, and the system is receiving its supply of water.

For pump shut down, the stop button is pushed. This de-energizes the coil of the solenoid 3-way pilot. The electric check valve starts to close at a predetermined rate of speed as regulated by the adjustment of the needle valve controlling flow of water to the top of the main piston. The pump continues to function. When the piston of the valve has completed about 95% of its stroke, the indicator rod permits the limit switch to break its contacts, which in turn shuts down the pump motor. In this way the water column is brought to rest fully supported, and without any opportunity for reverse flow. In the event of electrical outage the valve moves to the closed position, but can be provided with a secondary large emergency pilot which will accelerate the speed of closure.

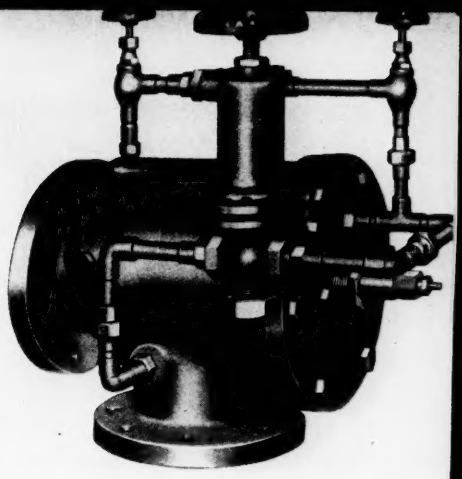


FIG. 3. CUSHIONED surge relief valve.

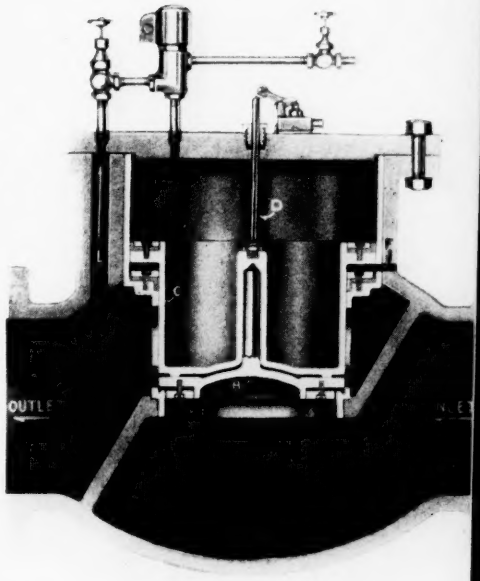


FIG. 4. ELECTRIC check valve.

Altitude Valve

This altitude valve (Fig. 5) installed at the base of a storage tank shuts off automatically when the water reaches its maximum level. It reopens to replenish the tank supply when the tank level lowers a few feet. Water is withdrawn from the storage tank either through a separate line or through a swing check valve in a bypass around the altitude valve. An alternate plan is to use a double-acting altitude valve which, in addition to controlling the high water level, also will open to return storage water to the system when system pressure lowers below the tank head. The single-acting valve type with swing-check valve in the bypass is recommended because it permits use of a smaller altitude valve which is more moderately priced, at the same time providing maximum water level control with a maximum return flow for emergency or fire fighting use. The altitude valve also can be equipped with a solenoid pilot for remote control from a central station.

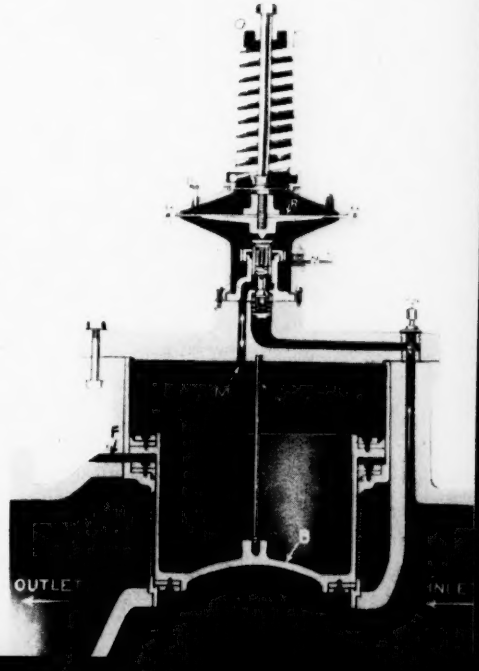


FIG. 5. ALTITUDE valve.

The valves already mentioned and other adaptations using the same self-operating principle have been used for many other iron and steel applications, including emergency city water connection for mill supply, liquid level control via probes or float switch, standby auxiliary pressure, emergency fire protection, spraying hot steel strip, hydraulic rams, elevators and classifiers, quenching coke, pig molds, ingots and die molds, loading tankers at dock, preventing flywheel explosion, and protecting power plant operation.

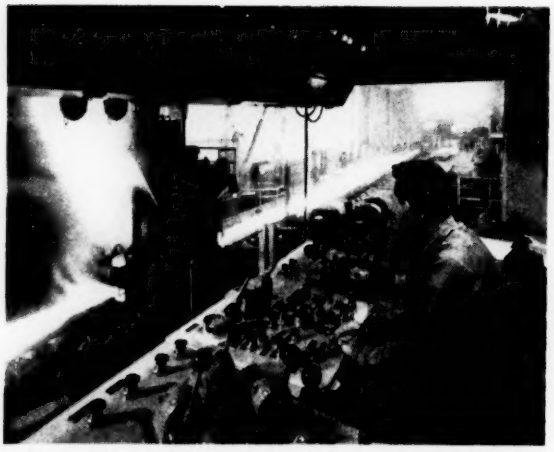


FIG. 1. OPERATOR MERELY PRESSES a pushbutton and this card-programmed reversing roughing mill rolls red-hot steel slabs automatically. One punched card contains all information necessary for nine passes.

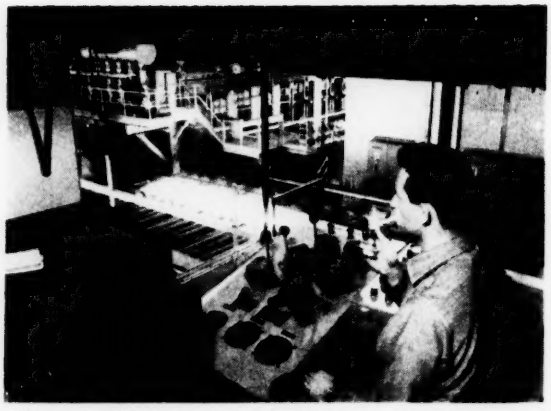


FIG. 2. OPERATOR HAS LITTLE to do when the reversing rougher is controlled by Prodac (programmed digital automatic control). At left is the IBM card reader. Cards is inserted by the operator who then pushes a single button on the left of the control board to initiate the complete roughing mill sequence for a given slab.

Automated Reversing Rougher

E. H. BROWNING

Westinghouse Electric Corp.

PRODAC (Programmed Digital Automatic Control) is directing a 6000-hp universal reversing roughing mill (Fig. 1) that feeds a six-stand continuous hot-strip mill at Jones and Laughlin Steel Corporation's Aliquippa (Pa.) Works. The system was designed, developed and manufactured by Westinghouse Electric Corporation during almost two years of work by J & L and Westinghouse engineers.

PRODAC Operation

The operator brings the slab coming from the primary mill onto the entry table and places a corresponding IBM punched card into a reader unit (Fig. 2). The operator pushes one button which causes the card to pass through the reader where information is transmitted from the card to a memory storage element that remembers each phase of the roughing operation.

A single punched card supplies this information:

1—Horizontal roll opening (screwdown), which changes after each pass through the mill, is adjustable from 0 to 14" in 1/32" increments.

2—Vertical roll opening (holds the edge on the slab and determines its width) from 6" to 44" in 1/16" increments.

3—A selection from six speeds for the mill tables and feed roll from 115 fpm to 1100 fpm.

4—Draft compensation.

5—Direction of the mill.

6—Scale breaking edger adjustment.

7—Scale breaking edger side guards.

8—Scale breaking edger descaling sprays.

9—Descaling sprays on the delivery side of the mill.

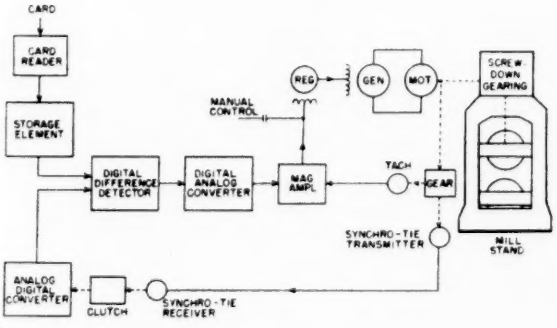


FIG. 3. SCHEMATIC DIAGRAM SHOWS signal flow controlling screwdown, or the vertical opening between rolls. When the operator presses the pass advance button to initiate rolling operations, digital reference information for the desired roll separation is extracted from storage and supplied to the digital difference detector. At the same time, the analog signal corresponding to actual roll separation is passed through the A-to-D converter to the digital difference detector. Here a subtraction operation yields a resultant signal representing the difference between the actual and desired roll separation. This signal is then processed by the digital-to-analog converter to yield an analog signal for input to the magnetic amplifier. Output of this magnetic amplifier is supplied to a rotating regulator and an adjustable voltage drive adjusts the screws until roll separation is equal to that originally specified by the punched card. Similar channels control mill speed, edger speed, and edger opening.

The use of tonnage oxygen as a tool for increasing the production of blast furnaces, Bessemer converters and open hearths has come into prominence during the past few years. This oxygen plant uses low-pressure (80-90 psig) centrifugally compressed air to produce 93-95% pure oxygen without chemicals.

Oxygen-Plant Control

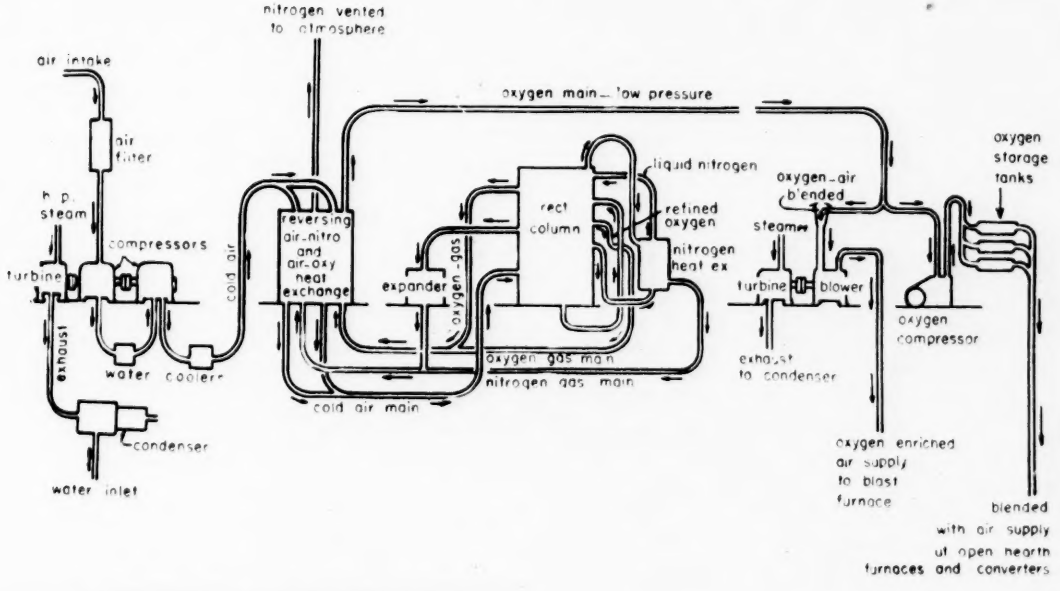


FIG. 1. SCHEMATIC OF OXYGEN PLANT. Air is cooled as it passes down through the air-nitrogen and air-oxygen heat exchangers by the cold oxygen and nitrogen; this removes water vapor and carbon dioxide from the air. Liquid air is introduced into the high-pressure side of the rectifying column at the bottom of the heat exchangers. Crude oxygen and nitrogen are expanded into the low-pressure side of the column from the high-pressure side through expansion valves. The oxygen stream also goes through a heat exchanger with the product oxygen, and through a purifier which removes any hydrocarbons. The product nitrogen leaving the plant goes through a heat exchanger with the air entering the high-pressure column. Part of the product nitrogen from the low-pressure column is expanded in a turbo-expander operating at 17,000 rpm and driving a generator. This colder nitrogen is introduced with the nitrogen entering the heat exchangers. Air that has been dried in an activated alumina drier is circulated through the plant on start-ups or defrosts. The expanders are used for initial cool-down and for make-up of "cold-loss" during operation.

ROBERT FRANCY

Weirton Steel Corporation

A 400-TON-PER-DAY oxygen plant (Fig. 1) was constructed by Weirton Steel Company and put into operation early in 1951. It furnishes approximately 10,000,000 cu-ft-per-day of 93-95% pure oxygen.

The oxygen produced at the oxygen plant is sent to the blowing room under 2-psig pressure (Fig. 2). The surplus oxygen from the plant is compressed for

Presented at 7th Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March, 1957.

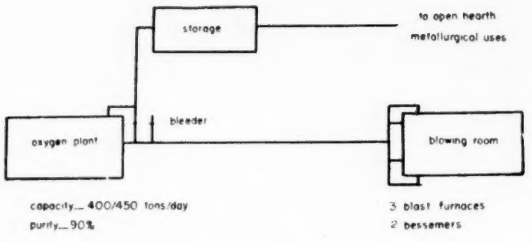


FIG. 2. BLOCK DIAGRAM of oxygen plant and related facilities.

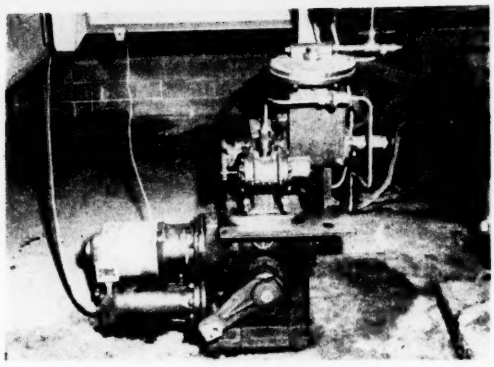


FIG. 3. THIS REGULATOR BETWEEN the storage tank and the blowing room reduces the 300-psig storage pressure to 1.8 psig.

storage in a 300,000-cu-ft tank at 300 psig. The storage oxygen is reduced to 120-psig pressure for use in the open hearth.

The line connecting the storage banks to the blowing room has a reducing regulator (Fig. 3) which reduces the pressure of the storage banks down to 1.8-psig pressure for the blowing room. Storing the surplus oxygen and then using the stored oxygen for pressure make-up avoids any bleeder loss. The make-up regulator also carries the load when the oxygen plant is reversed.

Fig. 4 shows the two-stage 46,000-cfm blower (driven by a 10,000-hp steam turbine using 300-psig steam) that supplies air to the oxygen plant. There are three air cleaners ahead of the blower and two heat exchangers: a cyclone after the blower provides cooling and water removal.

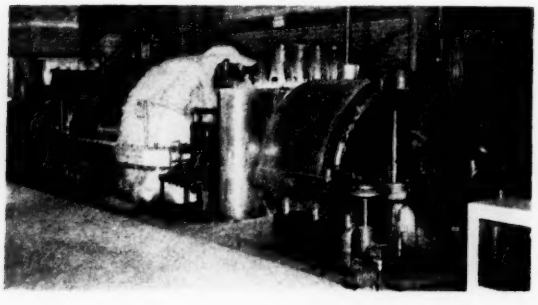
Control Panels

The steam control panel in the oxygen plant is shown in Fig. 5. The cooling water used on the intercoolers is recirculated: the controls at the far left end of the panel are for the pumps and fans of the cooling tower. The adjoining panel contains air flow and oxygen pressure recorder, oxygen flowmeter, oxygen pressure-relief control, and nitrogen pressure-relief control. The next two panels contain the usual instrumentation for control of a steam turbine. The turbine speed is controlled by an air volume control as well as by a separate speed control. The panel on the right contains the equipment for controlling the turbo-expanders.

Fig. 6 shows the oxygen control panel (which is on other side of steam panel shown in Fig. 5). The controls for operating the switch valves are at the left. These valves are hydraulically operated by pilot solenoid valves energized from a timer. In the next panel are two liquid-level indicating recorders for the liquid in the high- and low-pressure columns. The next group of instruments indicate and record temperatures of 150 points throughout the plant. The recorders are used on start-ups and defrosts. At right is a nitrogen temperature recorder and an oxygen purity recorder. The pressure gauges along the top of the panel show pressures throughout the plant—starting at the air blower (left) and ending at product oxygen (right).

The oxygen control panel at the blowing room is shown in Fig. 7. As originally designed, an oxygen control system was built for each turbo-blower and one moisture control system for the group, with the intention of using oxygen and moisture on one furnace only. In actual operation oxygen and moisture

FIG. 4. AIR IS SUPPLIED to the oxygen plant by this two-stage blower.



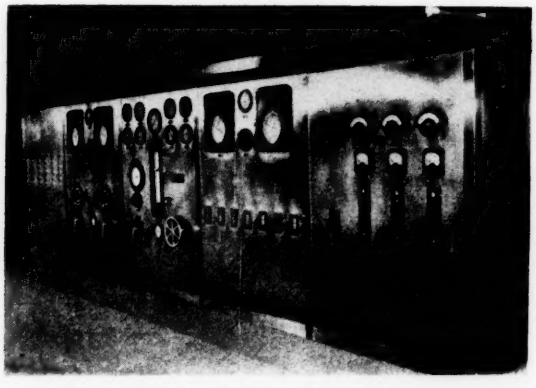


FIG. 5. STEAM control panel.

have been fed to four furnaces and some of the control equipment is at other locations. Starting at the left of Fig. 7, the first four panels contain an oxygen flowmeter, the ratio control, and oxygen motor-valve operator for each of the four turbo-blowers. The next panel is an oxygen pressure control and recorder. Next is a steam flowmeter and, finally, the natural moisture meter and one of the turbine moisture meters. On the end panel are the inlet air temperature instruments and pushbutton stations for controlling the motor valves on the air heaters.

Moisture

There is a sample connection for moisture determination about 100' downstream from the turbo-blower. A continuous stream of air is bled from the sample line, a part of which passes through the dew cell.

Fig. 8 shows dew-cell installations, two steam flowmeters and two moisture recorder-controllers. The temperature of the dew cell is recorded on the dew-point recorder-controller as grains per cubic foot. The temperature of the dew-cell air sample is maintained by the amount of air bled out of the sample line. As the rate of change of temperature is slow, the valve is adjusted manually from time to time to keep the cell temperature within limits. By using a nomograph and comparing the natural moisture, the steam flow and moisture actually being blown, it is easy to see when anything gets out of line with the moisture control.

Blast Furnace Top Gas

The use of oxygen in the blast furnace requires collecting and posting operating data for analysis. Previous to the use of oxygen, continuous gas samples were taken and analyzed on a precision gas machine. These records were kept for comparison with analyses made after the oxygen program was underway. Using the precision machine introduced a long time delay between taking the sample and seeing the results. To eliminate this time lag and also the loss of materials in collecting samples, a continuous gas analyzer (Fig. 9) was installed to measure carbon dioxide, hydrogen and carbon monoxide in the blast-furnace top gas. Eventually four of these machines were put in service.

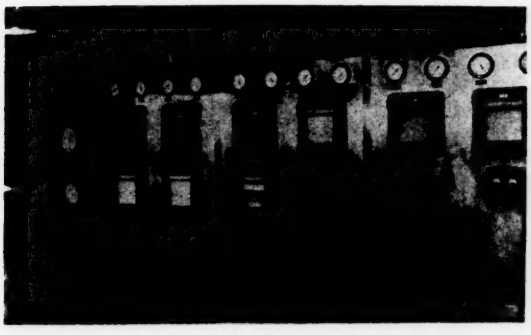


FIG. 6. OXYGEN control panel.

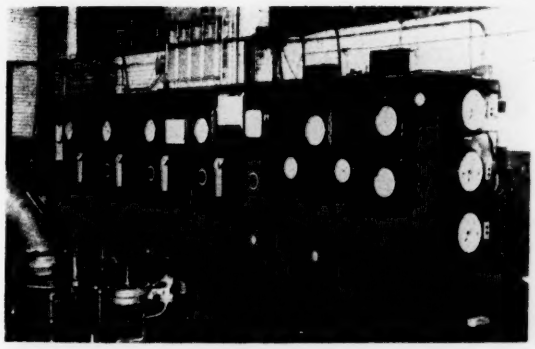


FIG. 7. OXYGEN CONTROL panel at the blowing room.

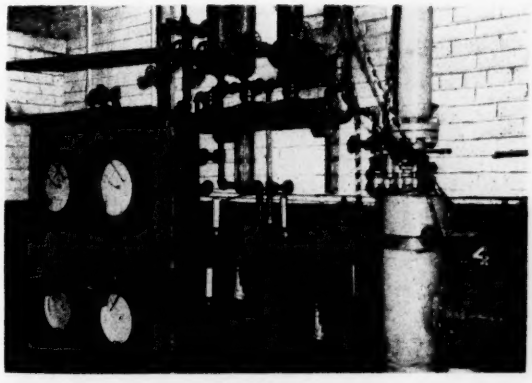


FIG. 8. DEW-CELL installations.

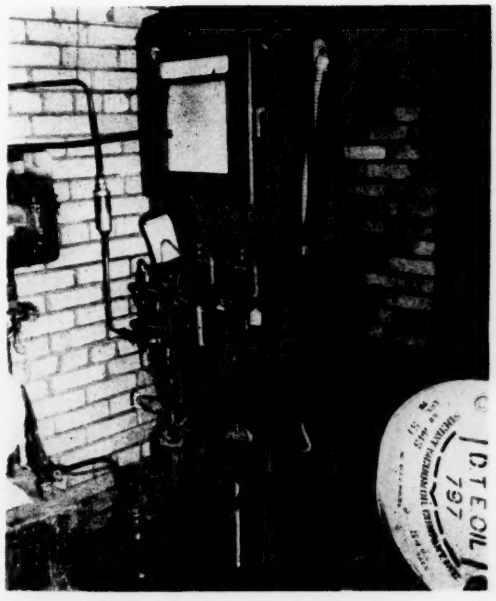
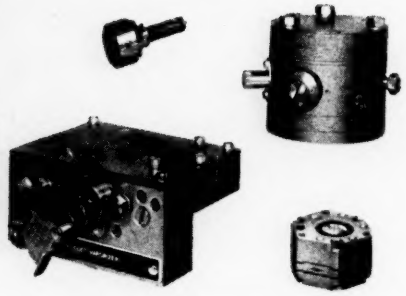
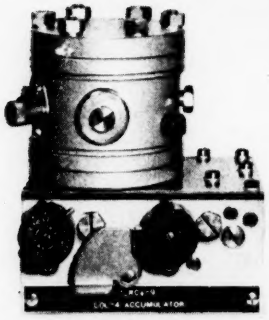


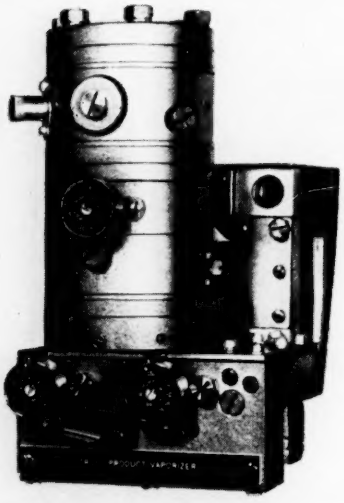
FIG. 9. FOUR OF THESE continuous gas analyzers sample blast furnace top gas.



Easily disassembled—Unitized construction of all controller components simplifies maintenance . . . makes reassembly foolproof. No need to dismantle stack to clean pilot assembly.

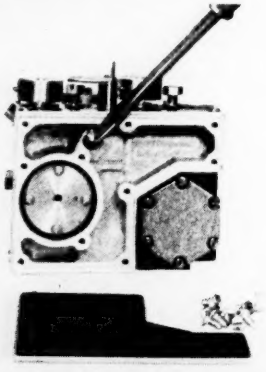


Easy accessibility—All adjustments, filters, and restrictions are easily reached on the face of the controller. Control action is reversed by turning reversing plate 90 degrees.

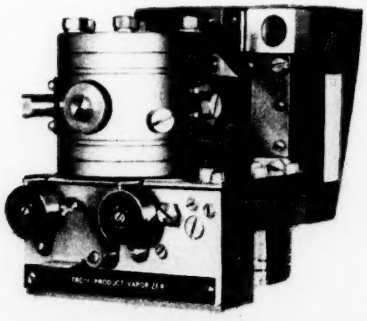


Rate action easily added—Add rate action simply by removing deviation section, inserting longer studs and rate unit, and replacing deviation section.

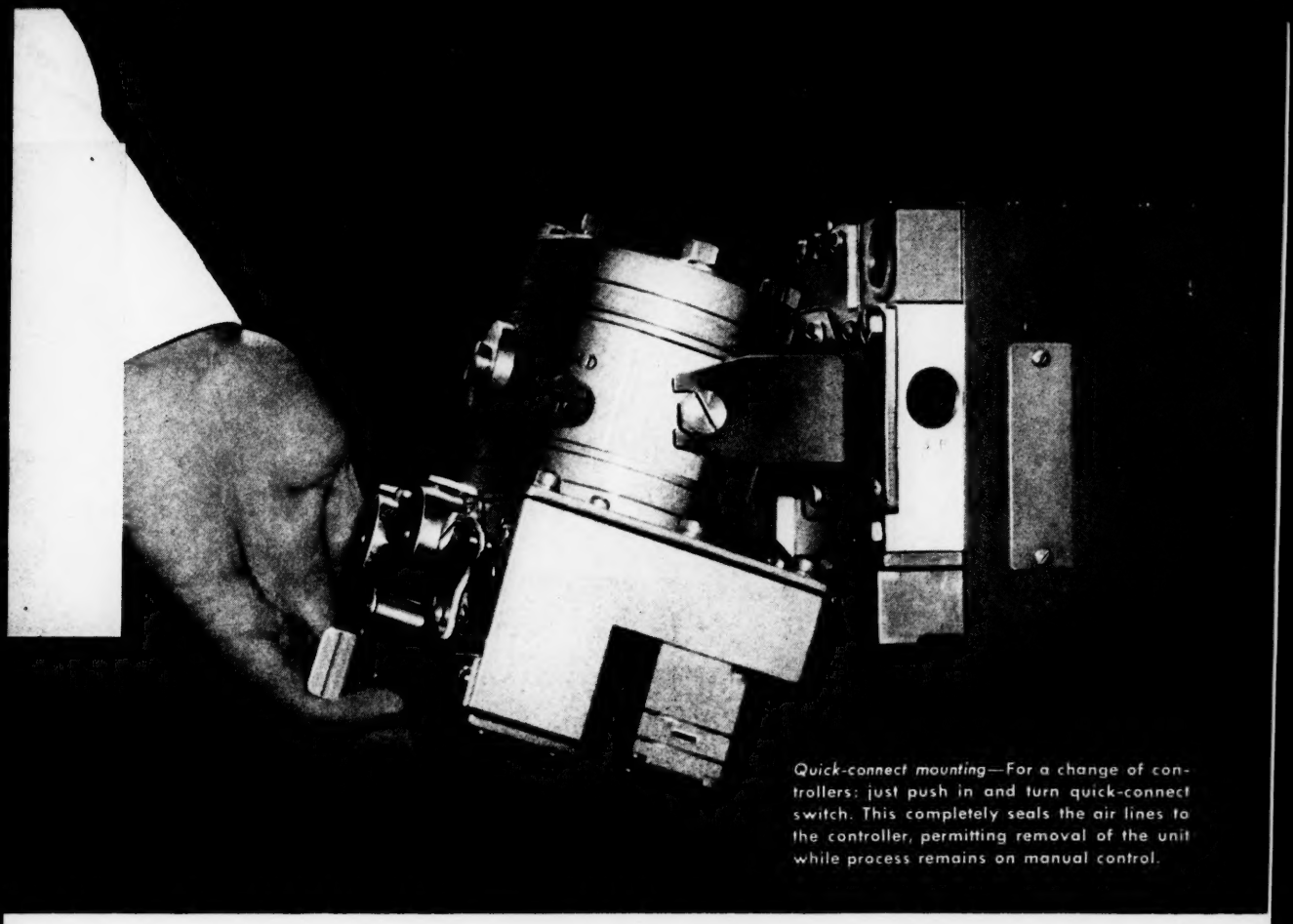
with the simplicity of



Three ranges of reset rates—Move a single sealing screw for choice of three reset ranges: 0.2-100, 0.01-5, or 0.04-20 repeats per minute.



Field-mounting manifold—Furnished for installations where controller is not mounted on the recorder. Has same quick-connect arrangement as rear of recorder, and external reset feedback or bypass relay for bumpless transfer from automatic to manual control.



Quick-connect mounting—For a change of controllers: just push in and turn quick-connect switch. This completely seals the air lines to the controller, permitting removal of the unit while process remains on manual control.

TEL-O-SET* controllers

New and improved *Tel-O-Set* controllers are low in cost, easily installed, compact, and require minimum maintenance. You can use them to control any process variable. One basic model serves for all applications. You can mount the controller anywhere: rear of receiver case, back of panel, or on the valve.

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Motor Current as a Process Indication

CLIVE LAWLER-WILSON
U. S. Electrical Motors, Inc.

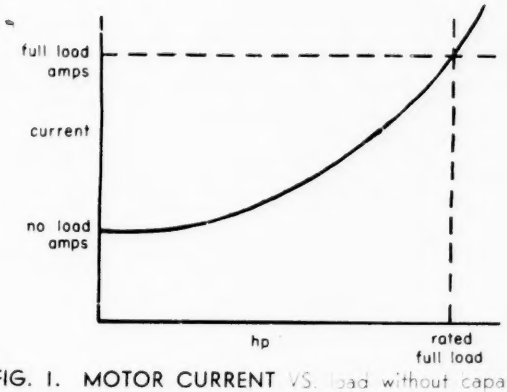


FIG. 1. MOTOR CURRENT VS. load without capacitors.

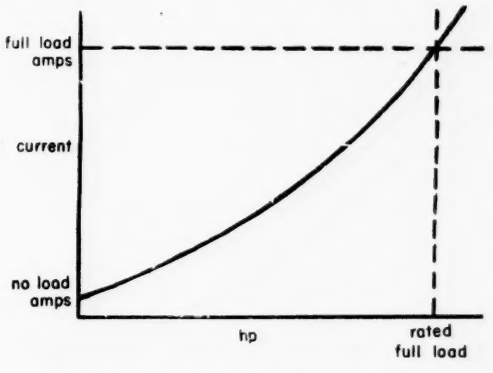


FIG. 2. MOTOR CURRENT VS. load with capacitors.

A THREE-PHASE induction motor without capacitors has a typical motor current versus load HP as indicated in Fig. 1. The current has a definite value at no load. Up to about 25% or 30% load the slope of the curve is shallow; above 30% the slope increases rapidly. For a given motor the current can be used to define the load, provided the motor voltage is constant.

Below 30% load the definition of motor load by motor current will be relatively inaccurate. For a motor running without capacitors, it is only above 30% load that the current can be used as an accurate indication of load.

In order to extend this current-indication principle below 30% load, the current-HP curves must have a reasonable slope in this area. This can be achieved by placing capacitors across the motor leads such that the no-load power factor is reduced to unity. The resulting current-HP curve (Fig. 2) is now useful and is demonstrated in the following two applications.

MARCH MEETING: Thursday, the 20th, Rio Hondo Country Club, Downey, California.
FEATURE: Mr. J. G. Ziegler of Taylor Instrument Companies will discuss, "Short-cuts in Control Analysis".

Mass Flow of Grain

Fig. 3 shows grain fed from a hopper to a grinder by a conveyor. It is required to obtain a signal representing the mass flow of grain and to design a control system which will adjust conveyor speed automatically to maintain the mass flow constant at the value best suited to the grinder.

The desired mass flow is the full load of the grinder motor. Below full load there is less efficient grinding and throughput is decreased. If the grinder runs above full load it tends to choke and the motor overload relays pull out with resultant downtime.

A solution can be found by sensing the grinder motor current with a current transformer in one of the motor leads. This is rectified to a low-power dc signal and converted to a proportional air pressure in the range 3-15 psi. This air pressure now represents motor current and constitutes the process signal.

A control station provides a pneumatic *set-point* signal corresponding to the full-load current of the grinder motor. Both process and set-point signals are fed into a pneumatic controller having proportional

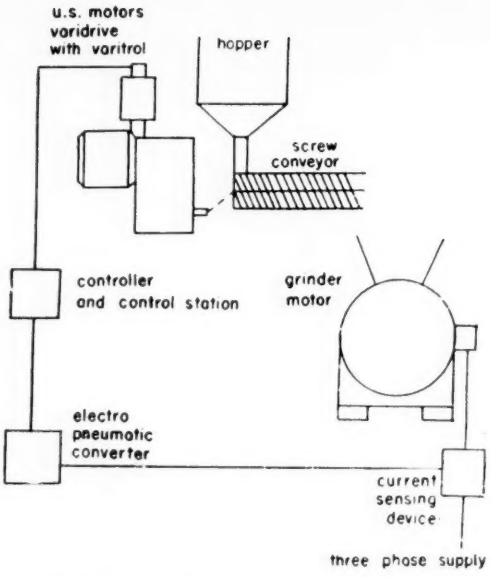


FIG. 3. LOAD CONTROL VARIES conveyor speed to maintain maximum use of grinder capacity.

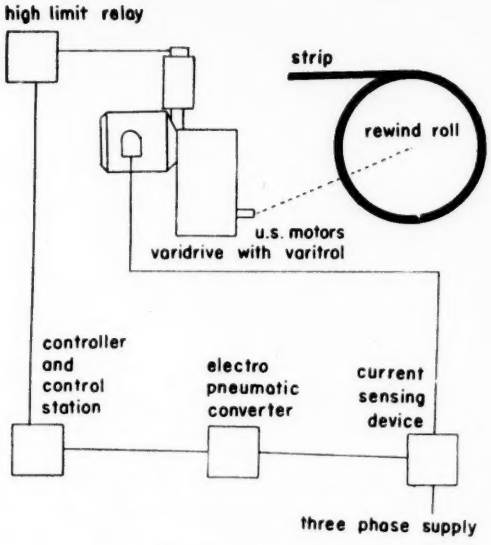


FIG. 4. LOAD CONTROL VARIES speed of rewind driving motor to maintain constant tension in strip.

band and reset and its output is piped directly to the Varitrol*.

If there is any difference between the process signal and the set-point signal the controller senses the magnitude and direction of this difference and the controller output adjusts the speed of the conveyor to bring the process signal back to the set point.

Constant Tension Rewind

After finish cold rolling of aluminum strip it is wound onto a mandrel under constant tension. During coiling the material is stretched giving the metal its final required dimensions and physical properties. The control of tension is therefore critical; dancer rolls or similar devices are not permitted to touch the material as this could mar the finish.

The material comes from the finish rolls at constant linear velocity and the strip tension is constant so the useful power expended at the re-wind roll will be constant throughout the windup. The input power has to maintain this tension and also supply the windage and friction losses. If the losses do not vary appreciably during wind-up, the motor driving the wind-up roll will be loaded to constant HP.

A Varidrive with Varitrol powers the re-wind roll. A current transformer is placed in one leg of the motor leads and control instrumentation provided to maintain the Varidrive motor input current at a constant value during wind-up; this value is established at a control station. The instrumentation is very similar to the load control system and is shown in Fig. 4. The input current defines the HP load; with constant current the HP is constant, and hence the tension is also constant.

In the first case of load control the system maintained the load HP constant on another motor. Here the Varidrive changes speed to keep its own HP load constant.

Advantages and Limitations

The basic advantages of control via motor current include simplicity of equipment and installation, dependability, and low cost.

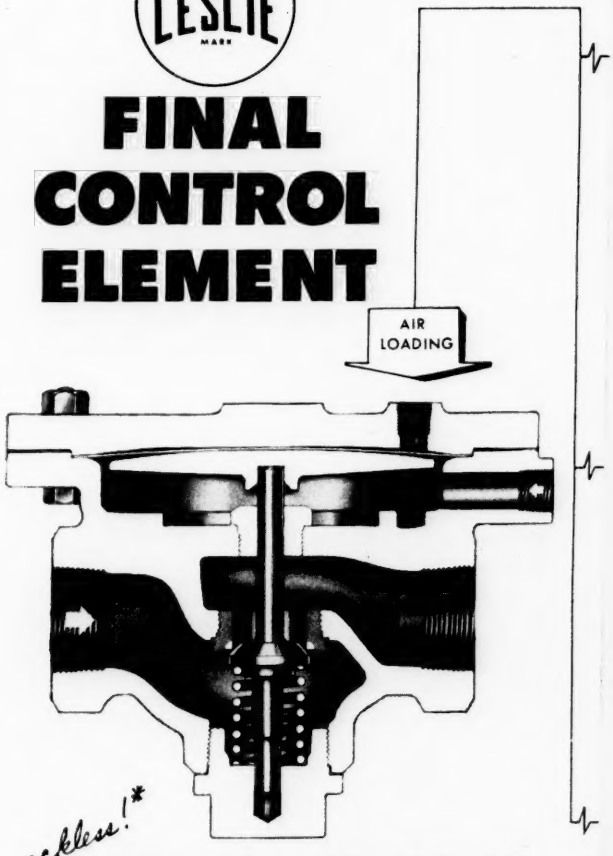
The limitations include (1) susceptibility to voltage variation, (2) curve of current vs load is nonlinear and (3) capacitors should be used if control is desired below 30% of full load. None of these limitations are of serious consequence in closed-loop control applications.

Other possible applications include:

1. Measure of fluid flow under constant head.
2. Measure of air or gas flow when applied to ventilation systems, heat transfer applications, forced-feed of combustion systems, etc.
3. Indication of liquid level when pumping constant flow against it.
4. Indication of extruder back pressure or extrusion rate (plastic or camelback extruders).

*U. S. Motors Varidrive comprises an a-c induction motor driving a variable-speed shaft through a set (or sets) of reciprocal-cone pulleys. The a-c motor runs at approximately constant speed; the speed of the output shaft is adjusted by changing the effective belt ratio by moving the cone-pulleys axially. This is done pneumatically by an integrally-mounted cylinder Conomotor equipped with a Moore Products Positioner that shifts the pulleys in response to a low-power air signal in the range 3-15 psi (the Varitrol system).

A NEW LESLIE FINAL CONTROL ELEMENT

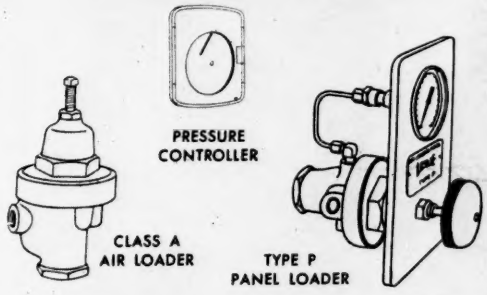


packless!*

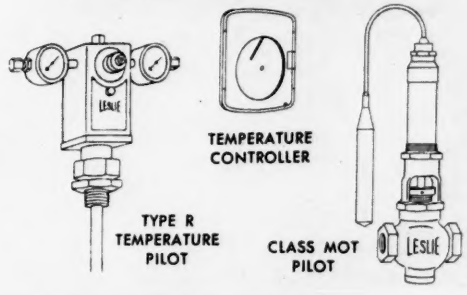
A REALLY VERSATILE CONTROL VALVE — with only two moving parts and a metal diaphragm*

OPERATE THIS CONTROL VALVE With ANY Of These PNEUMATIC DEVICES

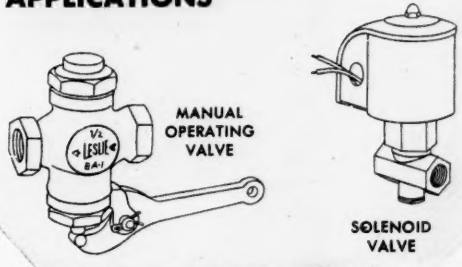
PRESSURE REDUCTIONS



TEMPERATURE REGULATION



REMOTE STOP VALVE APPLICATIONS



Now, simplified instrumentation combines the simple air loaded, Leslie diaphragm operated valve with various air operated devices. This is the valve that filled a real need when introduced about a year ago, wearing a 3-year guarantee against maintenance in normal pressure reducing services.

This new final control element is gaining wide acceptance for use with a variety of pneumatically operated controllers — simplifying pressure reductions, temperature regulation, remote stop valve applications and many process steam control services.

Ideal for "problem" installations

This control valve is ideal for either continuous or intermittent service and has remarkable immunity to dirty steam. Furnished in cast iron, sizes ½ - 2", it is suitable for any steam service up to 250 psi, 450F, and many fluid services.

It's simple — it's accurate

This Leslie control valve has only two moving parts ... no fussy seals, no stuffing boxes, no small dirt-catching parts; yet, with all its simplicity, it provides uncanny accuracy with its double* feed-back action. It lends itself readily to remote adjustment, too.

More Information

Ask your Leslie engineer to tell you more about this really versatile valve and the simplified instrumentation "packages" now available. You'll find him listed in your classified directory under "Valves" or "Regulators" and eager to come up with new ideas for simplifying pressure, temperature and liquid level control systems.

Send for Bulletin 561-A

* These are the President's comments — even the ad manager didn't know all the fine features!

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REGULATORS and CONTROLLERS

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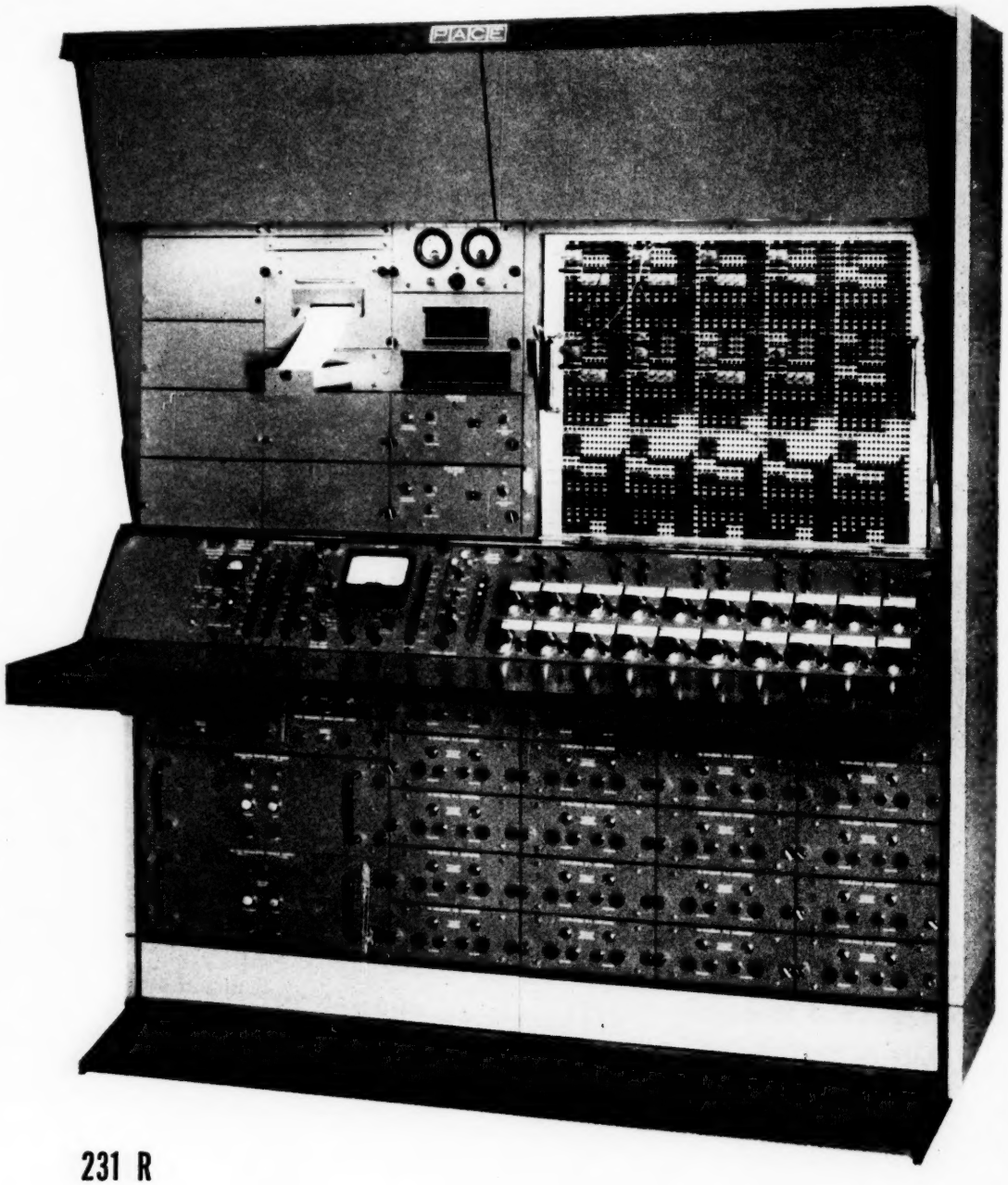


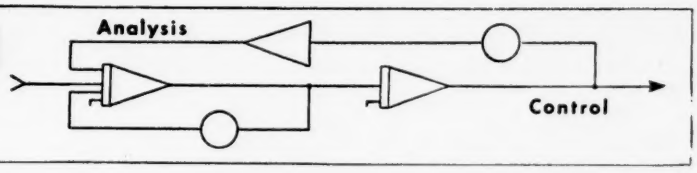
231 R

Symbol of the greatest advance in analog computing techniques——announcing PACE Analog Computer Console 231 R. This console incorporates new and exclusive features that enable it to set new standards in the art of analog computing for speed, precision, and reliability. For full information, write for bulletin number CG-116, Electronic Associates, Inc., Long Branch, N. J.

Visit our booth #1202-8, IRE Show, March 24 to 27.

For more information circle **57** on inquiry card.

The SIMULATION COUNCIL Newsletter



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Bits

This has been the most difficult Newsletter I have ever had to edit. Not that the material wasn't in good shape—it was. The only trouble with the H. J. Harrington paper on the effect of the nonlinearities of electrohydraulic control valves was the difficulty of cutting it down to the proper size and level for this nontechnical Newsletter. I hope I have succeeded; if not, please be referred to the AIEE article by Mr. Harrington and J. Zaborszky, cited in "Pieces." And Hideo Mori did his usual good job in his writeup of the Eastern Simulation Council talks on the simulation of jet engines.

The thing which made ye Ed's job difficult was Suzy's Christmas present and the La Jolla weather, Christmas and since. The present was a surf board, and the weather has been perfect for trying it out. See my problem? S'a tough life!

Pieces

CENTRAL S/C MEETING OF NOV. 13 ON ELECTROHYDRAULIC CONTROL VALVES

H. J. Harrington (Missile Engineering Division, McDonnell Aircraft Corp., St. Louis, Mo.) presented a paper entitled "Analog Computer Simulation of Electrohydraulic Control Systems" before the Central Simulation Council, meeting in Kansas City on 13 November 1957. The paper describes analog techniques used in a detailed simulation of single- and dual-stage electrohydraulic control valves and their associated loads. Special emphasis is placed on the simulation of nonlinearities, including detailed descriptions of circuitry used for the following simultaneous nonlinearities in the single-stage system: current hysteresis; Coulomb friction on valve spindle, actuator piston, and load member; square-law damping on valve spindle; Bernoulli force on spindle; quadratic pressure-flow-rate relationship of valve; and special acceleration- and position-dependent damping terms acting on the load member. In addition, the simulation of flapper Bernoulli forces and the nonlinear pressure-flow-rate relationships of the four orifices in the first stage of a dual-stage valve are treated.

Because details of this valuable work are available in AIEE CP 57-780 "Generalized Charts of the Effects of Nonlinearities in Two-Stage Electrohydraulic Control Valves," only that part of Mr. Harrington's paper considered to have widest general application to simulation—the mechanization of nonlinearities—will be abstracted here.

Harrington on Nonlinearities

Several years ago McDonnell Aircraft was confronted with two distinct modes of instability brought about by the nonlinearities of servo systems. One of the modes was a hard-type, limit-cycle oscillation occurring at a frequency approximately equal to the natural frequency of the load being driven by the servo.

The mechanism of this oscillation remained a mystery for some time

until Mr. Harrington and his colleagues again attacked the problem as part of a generalized study contract let by the Applied Physics Laboratory of Johns Hopkins University. Out of this study came an analytical approach to the problem and two separate analog computer studies dealing with both single- and dual-stage valve systems.

The equations were simulated on a Reeves Model C-101 analog computer. About 65 high-gain amplifiers were used for the single-stage simulation and 75 for the two-stage simulation, as well as several diode function generators, multiplying servos, and other associated equipment.

Fig. 1 shows the simulation used for current hystersis. This circuit was chosen over the simpler two-amplifier, two-diode scheme because of its sharper hysteresis curve, and also because it introduces less phase lag at the higher harmonics.

Fig. 2 shows the circuitry used to generate the orifice (dashpot) damping term of the spindle equation. Spindle rate, $\dot{x}_\epsilon$, is used to position the shaft of a high-speed multiplying servo with $|\dot{x}_\epsilon|$ then picked off the arm of a potentiometer on which +100 volts exists on both ends. This signal is then inverted twice and appropriately fed across the high and low sides of a second servo potentiometer from which the quantity $\dot{x}_\epsilon$ times $|\dot{x}_\epsilon|$ is obtained.

The Coulomb friction simulation used for both the valve spindle and the actuator piston is shown in Fig. 3. Total acceleration is integrated to give rate, which is then inverted and fed to a high-gain amplifier employing only biased-diode feedback. The output of this amplifier rises at a slope equal to the gain of the amplifier (about 30 million in this case) until it is sharply cut off at the diode bias value, V. This limited output is then properly scaled and fed back as the Coulomb friction force term. This scheme was found to give good performance for very small input signals and did not suffer from relay chatter as do circuits employing differential relays.

Fig. 4 depicts the circuitry used to obtain the spindle Bernoulli force term $Pa|X_\epsilon|$ and the valve flow rate. A multiplying servo is driven with spindle position X_ϵ, and one of the potentiometers is energized with $+Pa$ on both ends. The arm then is $Pa|X_\epsilon|$, the desired Bernoulli term. The quantity X_ϵ also drives a flip-flop circuit similar to that used in the Coulomb friction simulation. The output of the flip-flop amplifier energizes a differential relay so that either $+Pa$ or $-Pa$ is obtained from the relay arm, depending on the algebraic sign of X_ϵ. The sum of this signal and a constant, representing supply pressure, is then the instantaneous pressure drop across the valve. This quantity is fed into a diode function generator, and the square root of the pressure drop is brought out and fed to another potentiometer of the multiplying servo. The output of the arm of this potentiometer is then proportional to valve flow rate, namely X_ϵ times the square root of pressure drop across the valve.

The only critical item in this circuit is the square root device. A servo square-rooter is not satisfactory because the input function is discontinuous and so demands a faster response than is obtainable mechanically.

Fig. 5 shows the simulation of the load; everything is conventional except the handling of the complex Coulomb friction terms. For these terms, $\ddot{x}_1$ was solved for explicitly and then used to trigger a flip-flop circuit which, in turn, tripped a differential relay which switched algebraic signs of $\ddot{x}_1$ to give the absolute value of $\ddot{x}_1$ out of the arm. This quantity was then properly scaled and fed into a summer along with a similarly derived value of F_1c_2 times $|X_1|$ and also the constant term, F_1c_1. The output of this amplifier was then once more sent through a sign-switching relay, which was triggered by load rate, $\dot{x}_1$. The output of the arm of this latter relay is then the desired total Coulomb friction force.

The instrumentation of the first-stage equations of the two-stage valve represented the most serious problem in the over-all simulation. The equations were algebraic and the resultant analog circuitry did not possess the low-pass filter characteristics common to most feedback systems. Therefore the entire first-stage simulation tended to go unstable at a frequency of several kilocycles due to accumulated phase lag in the several high-gain amplifiers and nonlinear function generators. This was cured by holding the number of amplifiers to an absolute minimum, by using parasitic filters at various stra-

HYSTERESIS GENERATOR

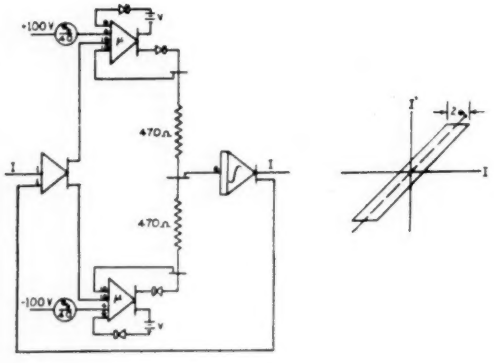

FIG. 1.

SIMULATION OF DASHPOT DAMPING

$F_d \dot{X}_\epsilon |\dot{X}_\epsilon|$

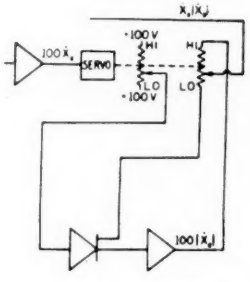

FIG. 2.

COULOMB FRICTION OF SPINDLE AND ACTUATOR

$M\ddot{X} + f\dot{X} + F\frac{\dot{X}}{|\dot{X}|} + kX = G(t)$

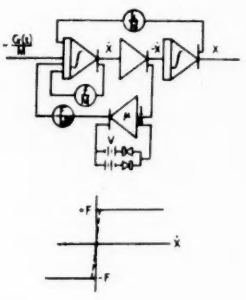

FIG. 3.

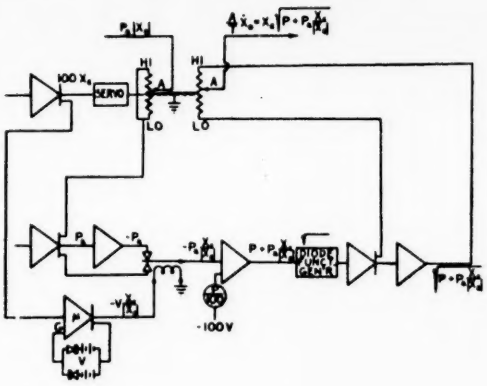

FIG. 4.

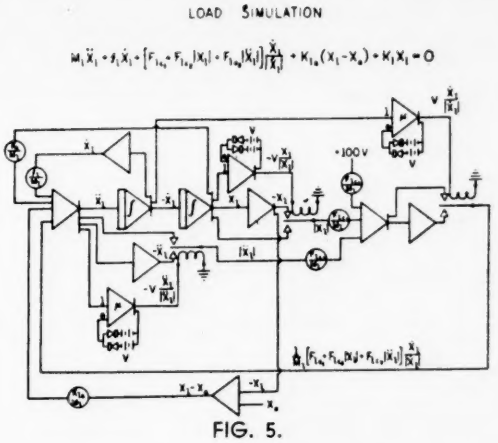

FIG. 5.

tegic points, and by performing the squaring operation of the fixed-orifice flow equations by means of nonlinear Thyrite resistors working into high-gain amplifiers. The final circuit configuration evolved only after many frustrating hours of trial-and-error attempts to eliminate the troublesome oscillations.

Although the instrumentation behaved quite satisfactorily for the limit-cycle stability study, it should be pointed out that other simulation techniques might be more nearly optimum for a transient performance analysis.

EASTERN S/C MEETING OF OCT. 14 ON SIMULATION OF JET ENGINES

About 65 members representing 25 different groups attended the seventeenth Eastern Simulation Council meeting at the Small Aircraft Engine Department of the General Electric Company, Lynn, Mass. on October 14th.

Five study groups met before lunch; however, the group led by Herb Wexler (AVCO) is the only one on which we have a report. At this meeting fourteen members, representing six companies, discussed the generation of linear accelerations to test devices such as accelerometers, and reviewed techniques—including the use of electromagnetic and electrostatic forces—which they had talked about in the past. They then discussed two of the more promising techniques in detail. One of these makes use of the earth's gravitational field to test accelerometers with a range below one *g*. In this case a simple servo would position the sensitive axis of the accelerometer relative to the one *g* vector. The other method, similar in principle, makes use of a centrifuge with a servo. In the latter case the servo would have to be insensitive to the accelerations exerted on it.*

This discussion led to a consideration of the simulation of atmospheric sensitive devices in which it was pointed out that physical simulation at AVCO will lead to mathematical simulation, which is a reversal of the usual procedure.

After an excellent lunch, courtesy of General Electric, the technical session—"Simulation As Applied to the Design of Jet Engines"—was opened by Bob Fraser, who welcomed the group on behalf of the host.

Edkins on Design Specs

The first speaker (all speakers were from G-E) was Denis Edkins, who spoke on preliminary design specifications for aircraft engines. This area is one in which a large number of engine and aircraft variables must be taken into account to produce an optimum design. Typical problems involve optimizing such variables as operating costs, take-off and climb rates, fuel consumption, etc. Most of these calculations are tedious to do by hand, but not difficult. Once set up, an analog computer takes only about two minutes to plot the various functions.

An interesting trick that the GE people have done on the analog equipment (which would be difficult to do by hand) concerns the cruising environment of an airplane. The economics of the problem involve three boundary conditions. One of them is drag on the aircraft, which makes it uneconomical to cruise above some critical speed. There is also a minimum speed below which aircraft cannot be controlled and flown comfortably. The third boundary is the cruising ceiling. A perfect airplane would meet all three conditions simultaneously. G-E uses the analog computer to optimize a realistic compromise.

Mr. Edkins described, as an example, a military aircraft which climbs at a certain rate and then turns on its afterburner and accelerates to supersonic speed. After a limited combat time it descends, turns back, and tries to ascend. During all of these maneuvers the weight is changing because fuel is being consumed. The problem of optimizing the climb is very difficult by analytical methods. Instead GE simulates a large number of climbs to find where an optimum occurs.

The engine was simulated by a function-of-two-variable generator, but simulating the pilot gave them considerable trouble. It was difficult to make the operation stable and also fast enough.

In answer to a question from Ro Favreau (Electronic Associates, Princeton, N. J.), Mr. Edkins explained that the reason an engine manufacturing company is interested in making these optimization studies is that it takes longer to develop an engine than an airframe.

Spring on Fuel Flow

The next speaker was Richard Spring, who described a nonlinear

*Limitations of both these methods, even in the static case, is that the accelerometers must be completely free from cross-coupling effects. When accelerations are changing rapidly, as is usually the case with the kind of dynamic systems for which simulation is most valuable, a much more severe limitation is imposed—the rapid rotation of the accelerometer required to produce the changes in apparent acceleration must produce no transient errors in the accelerometer output. —Ed.

control system which was studied by simulating the control and the engine together. He explained the operation of a very simple turbojet engine and said that the primary purpose of the control system is to control fuel flow so that neither the temperature limit nor the maximum rate speed will be exceeded. At the same time, the control system must allow as high a temperature and speed as possible to obtain maximum power and efficiency.

Mr. Spring pointed out the complexities of a turbojet engine, which include a large number of nonlinearities. In fact, many of the significant nonlinearities are functions of two variables, namely fuel flow and speed. Another complexity is that the control circuit does not limit temperature during the acceleration period of the engine.

Katz on Control Evaluation

Herb Katz, who spoke next, talked about the dynamic control analyzer, a fancy term given to a closed-loop test stand for evaluation of control: a jet-engine simulator which he said should not be confused with the three megabuck simulator at Evendale.

The Aircraft Gas Turbine Division of GE, Herb said, more or less pioneered the use of analog computers. He reminisced that not many years ago they used mechanical differential analyzers with stenographers cranking in functions. They have evaluated controls by simulating the engine and putting the actual control system on a test stand. They have also used analog computers to simulate control systems with an actual engine on a test stand.

As mentioned, besides controlling thrust (called for by the pilot or flight-control system), the function of a control system is to protect the engine. As it is usually not practical to wait for the engine to be developed to determine what the control requirements will be, analyzers use function generators to simulate the engine. Torque is a function of speed and fuel flow. In most cases engine controls are speed control systems. If the speed is not correct, they change the fuel flow to correct the error. Using the fuel flow and speed, and appropriate function generators, the torque is simulated. The unbalanced torque is then integrated to produce a change in speed. High-response flow sensors are necessary to maintain a one-to-one time scale. A high-response forward-drive system, as well as pressure measurements, are necessary.

The usual device for measuring pressure is a fast servo operating a bellows. A special 15-hp hydraulic drive system, used at GE, covers the range from 2 to 300 psia, and is flat within 3 db from 1/10th to 40 cps. The aerodynamic lag is negligible; when the fuel flow is changed, the heat value related to the pressure changes almost instantly.

Asked by Herb Wexler about the accuracy of the pressure system, Mr. Katz replied that it was within plus or minus 1% in a 6 cu ft chamber.

Dumont on Compressors

Lincoln Dumont next spoke on the applications to compressor design of an analog computer at GE. Mr. Dumont gave a brief description of what a compressor does and where it fits into an engine. The compressor draws in air at a very high rate and compresses it by a series of rotating and stationary blades.

In the design of a compressor, certain facts (like rate of air flow, the pressure rise required, and over-all dimensions) are known. From these the number of stages and the pressure rise per stage for the flow and speed conditions can be calculated. Mr. Dumont pointed out that in designing the turbine blades, the first step is to determine the direction and velocity of the air flow into and out of a typical blade row; only then can the design of a blade having appropriate aerodynamic characteristics be started.

Mr. Dumont said that an analog computer can be used to figure the required velocities. In determining the axial velocity in a blade row, solution of an integral equation is necessary, and the limits are the minimum and maximum radii of the blades. Different values are assigned to the unknown until the desired result is obtained. In the computation it was necessary to evaluate the function:

$$V = V_{aH}(R/R_H)^n$$

The V_a's are axial velocities. The R's are radii. The subscript H refers to the hub or minimum blade radius. The only variables are V_a and R. The first inclination might be to obtain V_a by using a function generator, but the following equation can be instrumented to obtain it directly:

$$d(V_a V_{aH}) = n\, d(R/R_H)$$

Gibson on Heat Transfer

The next speaker, Dave Gibson, told how heat transfer and temperature analysis problems can be solved. He pointed out the similarity between electrical and thermal circuits, and showed how the similarity is used to solve heat-transfer problems in turbo machinery.

Most heat-transfer problems involve a determination of the temperature profile required to evaluate thermal stresses. This, in turn, requires a determination of the heat-transfer coefficients. In a thermal circuit, thermal resistances, which are related to heat-transfer coefficients, may be the result of metallic conduction, convection, or radiation. The heat-balance equations which must be solved merely state that the heat flow in, minus the flow out, is equal to zero.

A resistive network is sufficient to solve steady-state heat-transfer problems. But to solve a transient heat-flow problem, capacitors must be added to simulate the ability of the material to soak up heat. Mr. Gibson showed how a turbine wheel is analyzed from a heat-transfer point of view. A big problem is the determination of the nodal points for the resistance network used for simulation.

The transient problem involves the calculation of clearances and temperatures between a rotating and stationary member in which the designer must consider the conditions during both acceleration and deceleration. If one of the members increases in temperature faster than another, clearances may change and a rub occur. A rub results in a point source of heat generation which, in turn, causes an accelerated failure.

During the question period Mr. Gibson stated that their analog model has been limited to about 30 nodal points, but that they have handled up to 200 on their 704 or 650. He also said that they used some nonlinear elements of a general-purpose computer for their temperature transfer study.

Information (Without theory)

So much material this month that we have had to hold the report on the joint meeting of the Western Simulation Council, the DDA Council, and the Los Angeles chapter of the Association for Computing Machinery on "Interrelationship of Analog and Digital Computers," and the combined analog and digital demonstration of a simulation, held at Ramo-Wooldridge on the 8th of January, until next month. We then also hope to be able to report on a paper that Mr. Fineberg presented at the November Central Simulation meeting.

More correspondence from abroad indicates that interest and progress in simulation are by no means confined to the U. S. Excerpts from two of these letters are given below. (Wish we knew what the Ruskies are up to!)

Mr. J.G.L. Michel, National Physical Laboratory, Teddington, Middlesex, England, writes, in part:

". . . As you probably know, we maintain in this Laboratory a digital computer (DEUCE)—with a further large-scale machine in construction—a servo-connected mechanical differential analyzer, and electronic simulator."

J. Kuntzmann, Director of the Laboratoire de Calcul, Institut Polytéchnique, Université de Grenoble, France, writes us that his laboratory has an analog computer built by the Société d'Electronique et d'Automatisme of 24 amplifiers which permits resolution of a system of 12 linear algebraic equations with 12 unknowns, of a system of 12 linear differential equations of the first order, or of any other equivalent differential system.

Nearer home, we hear from George Bekey of the Beckman Computation Center at 305 Parkman Avenue, Los Angeles 26, who states (among other things) that:

"We have been offering a one-week course in theory and application of analog computers here at the Beckman Computation Center approximately once every two months. The courses have been directed to people with limited experience in analog computing and have included lectures, discussions and computer operation by the participants.

"Beginning in January 1958 we will be offering two separate courses. One of these will be directed to persons with limited analog computer experience and will cover theory and applications. The second course, which is entitled "Advanced Applications", will cover such topics as frequency analysis, adjoint computation, solution of partial differential equations, simulation of servo systems and error analysis.

"Both courses are offered at no charge as a public service."

We note that Andromeda, Inc., 3742 Howard Avenue, Kensington, Maryland, is in the conversion field with an Analog-to-Digital Encoder and a Digital-to-Analog Decoder.

So is Packard-Bell, with their Multiverter, which goes both ways and throws in some free multiplication and division to boot. We have seen a demonstration of this gadget and were favorably impressed with both construction and performance.

We have received the following announcement from Lou Wadel, Acting Chairman of the 1958 National Simulation Conference: CALL FOR TECHNICAL PAPERS—NATIONAL SIMULATION CONFERENCE

The 1958 National Simulation Conference, sponsored by the Institute of Radio Engineers, Professional Group on Electronic Computers, and the Dallas Section of the Institute of Radio Engineers, will be held in Dallas, Texas, 23-25 October 1958, Statler-Hilton Hotel.

Technical papers in the general field of simulation are hereby solicited. Papers submitted must not have been presented previously at a meeting of national scope nor published previously in a nationally circulated journal. One-hundred-word abstracts and 500-word summaries to aid in paper selection should be transmitted in duplicate to the Technical Program Chairman:

Mr. D. J. Simmons
Route 8, Box 447
Forth Worth, Texas

The deadline is 25 June 1958.

In addition to topics such as the analog and or digital simulation of mathematical, physical, logistic, economic, biological, and chemical systems, papers are desired covering advances in analog computer system and component design, techniques, and applications, as well as new methods of determining and improving the accuracy of analog solutions.

No "proceedings" volume will be published as such, but authors of papers accepted for the conference will be expected to submit the full text of their papers to the *IRE Transactions on Electronic Computers* for consideration for publication in that journal.

He Went Thataway!

Tim Sutton to GPS Instrument Company (high-speed analog computers). Bob Franzel to Boeing (Bomark).

Computer Events

Western Simulation Council

Date: Thursday, 13 March 1958
Place: U.S. Naval Air Missile Test Center, Pt. Mugu, California
Subject: "The Use and Usefulness of Flight Tables in Simulation". A discussion of this topic by people who have had actual experience with various designs of flight tables will comprise the technical session, which will be unclassified.

There will be two tours: one in the morning of NAMTC in general, and one in the afternoon (following the technical session) of the Simulation Facility only. Both these tours will require security clearance of *confidential*.

For further information write with Willard Uplinger, Simulation Laboratory, USNAMTC, Pt. Mugu.

DDA Council

Date: Monday, 5 May 1958
Place: Los Angeles, California

Details as to place and subject will be announced later.

Western Joint Computer Conference

Date: May 1958
Place: Los Angeles, California

Details will be given next month.

1958 National Simulation Conference

Dates: 23-25 October 1958
Place: Dallas, Texas

The conference will be sponsored by the IRE Professional Group on Electronic Computers and the Dallas Section of the IRE. For information write Louis B. Wadel at 3905 Centenary Drive, Dallas 25, Texas.

new instruments

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FOR FURTHER INFORMATION USE THE POSTAGE FREE ORDER CARD ON PAGE 357

computing and data processing

ELECTRONIC COMPUTER

New ECS (Electronic Computation System) fills gap between giant "electronic brains" and mechanical

calculators; is completely transistorized and built into an office desk. Many repetitive business problems can be programmed into it in minutes by office personnel. It also solves many scientific problems and all straight arithmetical calculations.—*Clary Corp.*, 408 *Junipero St., San Gabriel, Calif.*

For more information circle **301** on inquiry card.

VOLTAGE-DIGIT CONVERTER

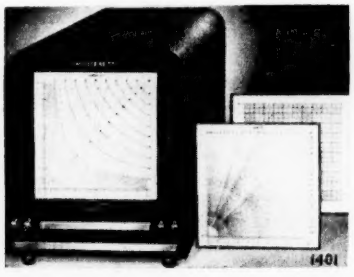
1428

New Model K Datrac permits digital computers to be used for study of the physical world in real-time Through it, a digital computer can be fed information directly from voltage sources such as thermocouples, pressure and strain gages, analog computers, etc., and be used for analog function generation, solution of equations, analysis of equipment performance, etc.—*Epsco, Inc.*, 588 *Commonwealth Ave., Boston* 15, *Mass.*

For more information circle **302** on inquiry card.

COMPUTING INDICATOR

New Model 66-500 Computerette is a unique electrical instrument which indicates two independent variables AND any function of these two: product, ratio or purely empiric function.


1401

Example: speed and torque, with hp derived. Two dc reflecting galvanometers project luminous lines extending across screen: horizontal line moves vertically; vertical line moves horizontally. In addition to the two scales on screen edges, each selected screen contains a family of curves such that the point where the two light lines intersect indicates the derived quantity.—*Aero Electronics Co.*, 1512 *N. Wells St., Chicago* 10, *Ill.*

For more information circle **303** on inquiry card.

MAGNETIC SHIFT REGISTER

1429

New Type SR-60 series of transistorized magnetic shift registers, designed to operate from 0 to 60 kc, have signal-to-noise ratios greater than 15 to 1 with voltage drops of 0.5 v across drive windings. As many as 30 elements can be driven with one transistor. Unique advantage: only one voltage source is necessary for both driver and shift register.—*Epsco Components*, 108 *Cummington St., Boston* 15, *Mass.*

For more information circle **304** on inquiry card.

PROGRAMMING SYSTEMS

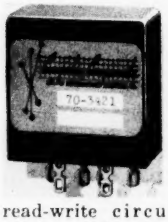
Two new interpretive floating-point coding systems for maker's G-15 General Purpose Computer: (1) Intercom

1619

500 handles numbers made up of 5 decimal digits and a 2-digit exponent; (2) Intercom 1000 handles numbers of 12 decimal digits and a 2-digit exponent.—*Bendix Computer*, 5630 *Arbor Vitae St., Los Angeles* 45, *Calif.*

For more information circle **305** on inquiry card.

PULSE TRANSFORMER

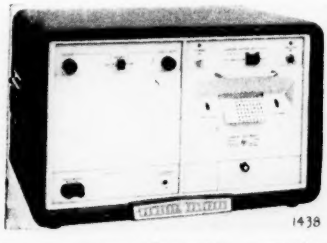


New Series 70-3420, for high-speed high-current magnetic recording head drive circuits, has primary and secondary as well as two secondaries close-coupled to permit use as a read-write circuit. Turns ratio of 1:2:1 can be modified to match circuits for various heads.—*International Resistance Co., Computer Components Div.*, 401 *N. Broad St., Philadelphia* 8, *Pa.*

For more information circle **306** on inquiry card.

DIGITAL RECORDER

New Model 560A prints 11-column digital information at rates to five prints per second; can be used with


1438

two or more electronic counters simultaneously, digital voltmeters, time recorders, flowmetering equipment, engine test stands, etc., In addition to printed tape record, it provides an analog current or voltage output.—*Hewlett-Packard Co.*, 275 *Page Mill Rd., Palo Alto, Calif.*

For more information circle **307** on inquiry card.

ALPHANUMERIC PRINTER

New Magnityper is an integrated system featuring integral housing of mechanical printing assembly with

electronic storage and comparator system providing space and power economy, input adaptability to any source of digital data, and transistors and magnistors combined with modular type construction.—*Potter Instrument Co., Inc., Sunnyside Blvd., Plainview, L. I., N. Y.*

For more information circle **308** on inquiry card.

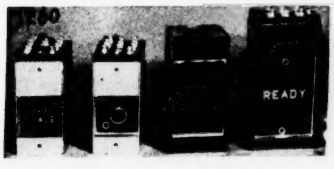
INPUT-OUTPUT SYSTEM

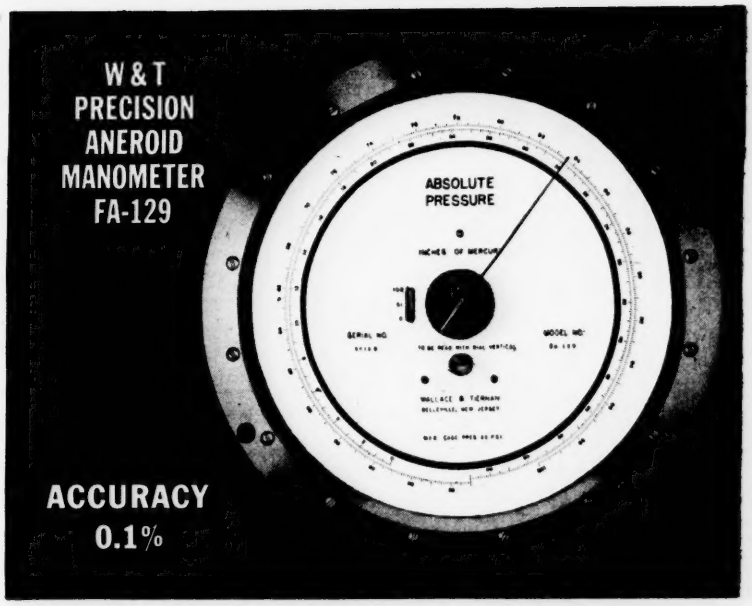
New Digital Tape System offers transfer rates as high as 90,000 six-bit characters per second; comprises four interdependent items: (1) FR-300 tape handler which operates at 150 ips and can record two 6-bit characters side by side on 1" tape (½" also available); (2) read & write heads; (3) electronics and (4) special magnetic tape. Heads, amplifiers and tapes jointly make possible packing densities up to 300 bits per inch.—*Ampex Corp., 934 Charter St., Redwood City, Calif.*

For more information circle **309** on inquiry card.

READOUT UNITS

New readouts enhance presentations in bench, panel, and console applications: (1) Digital Readouts present lighted digits and decimal point, polarity signs or special symbols; mount side-by-side. (2) Message Readouts will display, separately in





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...For Absolute Pressure Work

Ranges: 0 to 31.5 inches of Hg. absolute (min.)
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Other intermediate ranges available

Accuracy: 1/1000 of full scale

Sensitivity: 1/10,000 in *all* ranges

Scale Length: 45 inches in two revolutions

Dial Size: 8½ inch diameter

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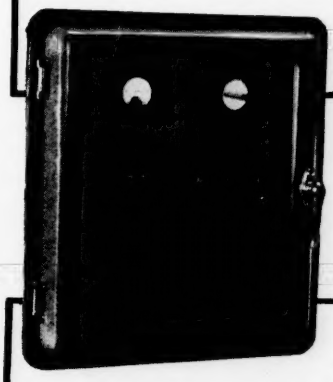

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3 PARTS CHLORINE
IN A MILLION PARTS AIR

New W&T Solvay Chlorine Detector*
detects as little as 3 p.p.m. chlorine in a continuous air-stream sample. Automatically sets off alarm at higher concentrations.

Write for Publication 50.118

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1-55 *Manufactured under patent license from Solvay Process Div., Allied Chemical & Dye Corp.

For more information circle **58** on inquiry card.

one panel area, up to three different color-coded printed messages. Message and color combinations made to suit individual requirements. Superpositioning of messages in readout minimizes required panel area and eliminates panel artwork and engraving. —*Milman Engineering Co.*, 1831 *Pontius Ave., Los Angeles* 25, *Calif.*

For more information circle **310** on inquiry card.

MISSILE TAPE RECORDERS

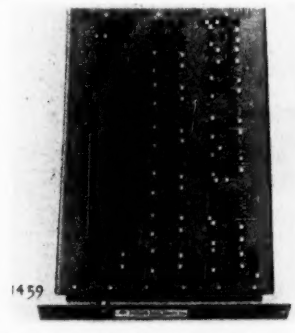
1453

New MR-50 Series of four High-G miniature tape recorders, for high-frequency response, have ten times the tape capacity of maker's smaller units and thus provide longer running times at higher tape speeds, permitting higher frequency response. All are 7-track recorders (6 data tracks and one for timing) with a built-in transistorized timing oscillator. Standard tape speeds 15 ips for MR-50, 51, and 52; and 30 ips for MR-53.—*Northam Electronics, Inc.*, 2420 *N. Lake Ave., Altadena, Calif.*

For more information circle **311** on inquiry card.

COMPUTER FOR MISSILES

New TRICE is the first digital computer reported to be "fast enough to evaluate the performance of a missile in full flight . . . can solve a complete set of equations every ten microseconds . . . 24 times faster than other digital computers." It was developed by maker for missile design studies at Army's Redstone Ballistic Missile Agency, not for general-purpose digital computation. Photo shows a basic module of TRICE.—*Packard-Bell Electronics Corp.*, 1925 *S. Bundy Dr., W. Los Angeles, Calif.*


1459

For more information circle **312** on inquiry card.

DIGITAL X-Y RECORDER

New Model 560 plots one variable against another; can move in both positive and negative directions on either axis. Aluminum drum is paper carrier while pen moves across paper. Both axes move in discrete increments of 0.01" at a maximum speed of 200 increments per second. Recorder can be used to plot any two variables from radiation counters, magnetic and paper tape readers, some types of digital pickups, etc.; can also be used to record one variable against time by introducing pulses at a uniform rate on one axis. It is completely transistorized and has its own power supply. For all practical purposes its accuracy is considered to be absolute.—*California Computer Products*, 3927 *W. Jefferson Blvd., Los Angeles* 16, *Calif.*

For more information circle **313** on inquiry card.

process analyzers, monitors, controllers

IR SPECTROPHOTOMETER

New IR-7 prism-grating infrared spectrophotometer—first fully automatic continuous recording instrument of grating type—is particularly suited for molecular structure analyses and other research; utilizes a replica grating in conjunction with NaCl prism, providing three times as much resolution as is possible with conventional double-beam double-prism spectrophotometers; features a unique order-changing system which permits continuous scanning from 650 to 4000 cm^{-1} (wavenumbers) and preserves linear wavenumber presentation.—*Scientific Instruments Div., Beckman Instruments, Inc., Fullerton, Calif.*

For more information circle **314** on inquiry card.

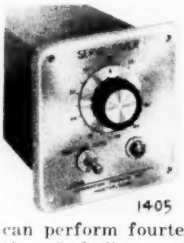
GAS BLENDER

1435

New gas analyzer for quality control of continuously-flowing binary gas mixtures features maintenance of close automatic control as set point of controller is changed to suit operation. Each system is engineered for individual application.—*Gow-Mac Instrument Co.*, 100 *Kings Road, Madison, N. J.*

For more information circle **315** on inquiry card.

PROCESS CONTROLLER

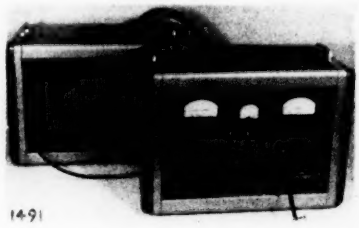

1405

New Servo Timer converts a measuring-element signal (temperature, pressure, flow, voltage, etc) into a proportional time interval or a proportional number of pulses; can perform fourteen different functions including an-dig conversion and other computing functions in addition to five kinds of time control, telemetering, etc.—*Automation Products, Inc.*, 3030 *Max Roy St., Houston* 24, *Texas.*

For more information circle **316** on inquiry card.

GAS ANALYZER

New Model A-6 Nitrogen Gas Analyzer uses RF energy instead of dc to excite gas sample, whence improved stability and accuracy. Base scale range 0%-100%; five vernier scale ranges from 0-20% to 80-100%; intrinsic response time better than 0.03 second.—*The Waters Corp.*, 402 *First Ave., N. W., Rochester, Minn.*


1491

For more information circle **317** on inquiry card.

DIGITIZING EQUIPMENT FOR MASS SPECTROMETERS

New "MASCOT" widens use of mass spectrometry by cutting present time-consuming process of measuring and tabulating peak heights; is completely unprogrammed, being designed to provide tabulated digital conversion of analog output from CEC's Type 21-103C Mass Spectrometer.—*Consolidated Electrodynamics Corp.*, 300 *N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **318** on inquiry card.

PARTICLE DISTRIBUTION ANALYZER

New Model A.1 (1-100-micron range) Micron Particle Distributometer, for production-control as well as testing and research, autographs a curve of weight *vs* time from which the distribution curve is readily obtained; features excellent reproducibility and exceptional sensitivity (for most common materials, output current for a <1-g sample often is full-scale for conventional recorders). No

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1 ohm to 5 megohms, 500 mmfd to 2,000 mfd, 3 millihenrys to 10,000 henrys.

- Five meter ranges: 1%, 2.5%, 5% 10% and 25% difference readings at full scale.
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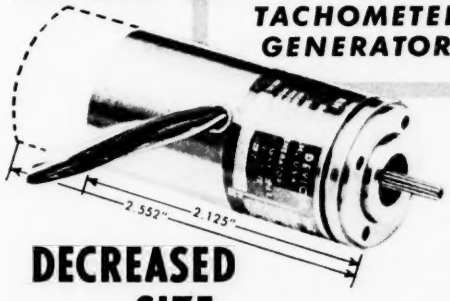
For more information circle **59** on inquiry card.

EAD's New Size 11 Servo TACHOMETER GENERATOR



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EAD's precision size 11, 115-volt motor tachometer is now available in a smaller package—and achieves improved electrical characteristics! It delivers 0.6 volts per 1000 rpm with 19 millivolts of total null. Lower nulls are available. Upper temperature reading is 150°C. EAD's new unit is available in variations of voltages and power ratings for transistor operations, variations in shaft and mounting configurations, etc. . . . and may be ordered with precision gear heads to your requirements. Write for more information.

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For more information circle **60** on inquiry card.

BROOKS LEADERSHIP
achieved by design

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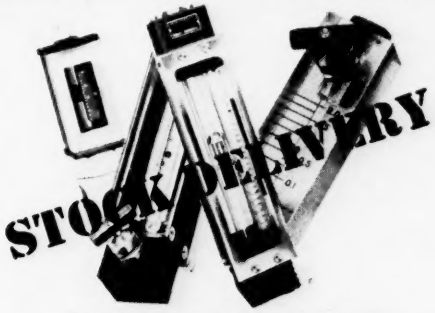

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Now you can use the same basic metering float for flow indication . . . transmission . . . alarm signalling. Now you can reduce spare part inventories and still have broad coverage of flow ranges.

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For more information circle **61** on inquiry card.

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Transducers

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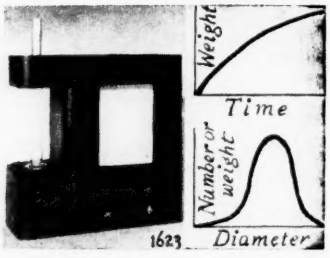
For more information circle **62** on inquiry card.

NEW INSTRUMENTS

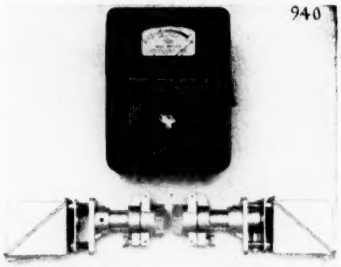


need of electronic counters, amplifiers, complex circuitry or conducting liquid. Sample preparation takes about one minute by unskilled operator; automatic run takes 15 to 150 minutes, depending on material and desired information.—*G. F. Bush Associates, Princeton, N. J.*

For more information circle **319** on inquiry card.

SMOKE DENSITY INDICATOR

New Fireye Smoke Density Indicator System FE-3 indicates and records smoke density in any duct or

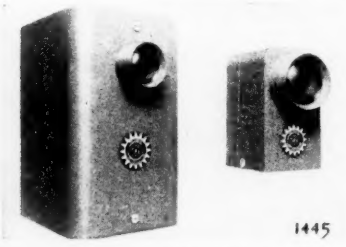


breeching that is pressurized: special pressure-seal flanges.—*Electronics Corp. of America, Combustion Control Div., 77 Broadway, Cambridge, Mass.*

For more information circle **320** on inquiry card.

photoelectric controls

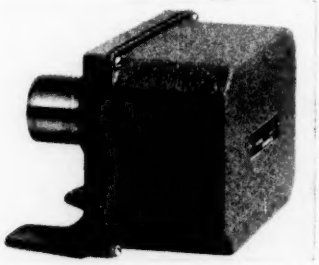
New MEK-5500 Series controls are available in several models for different modes of operation, adjustable



time delay, etc.—*Machinery Electrification, Inc., 56 Hudson St., Northboro, Mass.*

For more information circle **321** on inquiry card.

New photoelectric controls change from dark-energized to light-ener-



gized (or vice versa) with the flick of a switch.—*Autotron, Inc., P. O. Box 722-Q, Danville, Ill.*

For more information circle **322** on inquiry card.

pressure and vacuum

PRESSURE-TEST RECORDER

New Model 5770 Digital Pressure Recording System, for applications such as production testing of pressure switches, sweeps through a pressure range of 0 to 375 psi (for example) and prints out in digital form the values of pressure at which the devices operate. Output is a visual indication and four-line binary coded decimal to printer.—*Systems Div., Beckman Instruments, Inc., 325 N. Muller Ave., Anaheim, Calif.*

For more information circle **323** on inquiry card.

PRESSURE PICKUPS

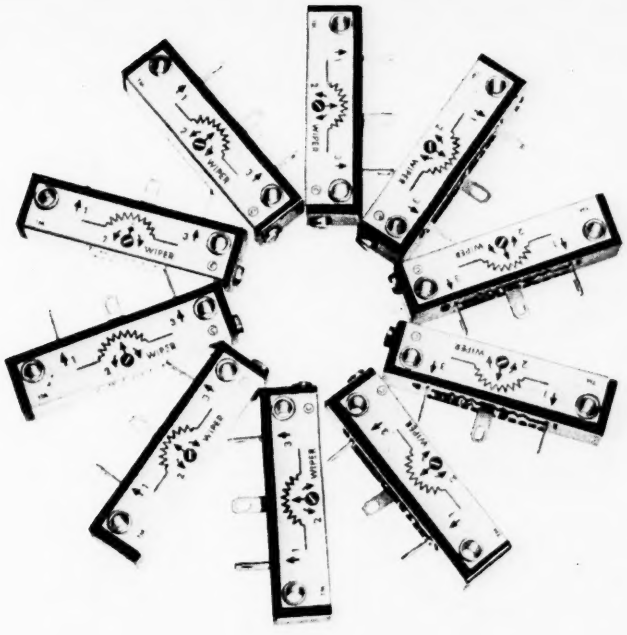
New flush-diaphragm ac variable reluctance type Series 1100 are suited for use in corrosive environment as 1" diaphragm and 2¼" long case are one piece, machined from stainless

steel. High output: about 1 v with 20 v excitation. Available ranges 0-100 to 0-3,000 psi; non-linearity 0.5% of full scale.—*Phillips & Hiss Co., Inc., 1145 McCadden Pl., Hollywood 38, Calif.*

For more information circle **324** on inquiry card.

VACUUM PUMPING STATION

New VS-9 fully-equipped high-performance high-vacuum pumping station combines mobility with versatility and modern design; features fast pumpdown, extremely high vacuum (with bakeout better than 10^{-8} mm Hg) high-speed air-cooled 85-lps dif-



HERE'S TRIMIT® ... A NEW TYPE OF ADJUSTMENT POTENTIOMETER FOR COMPUTERS, CONTROLS, COMMUNICATIONS, TEST EQUIPMENT

Compared with the average control-type single-turn rotary potentiometer, TRIMIT adjustment *accuracy* is a 33:1 improvement. TRIMIT provides 9000° of rotation instead of 270°. Easier repeatability, too.

TRIMIT *geometry* is a 6:1 to 12:1 improvement—you can mount 12 units in a panel area of only 1 square inch. They fit flat against printed circuits, into tight corners, between components.

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RFL Model 912
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The Model 912 Comvor, an audio frequency shift terminal, is used in the transmission of telemeter, telegraph or control signals over either wire line, microwave, or carrier. Up to 60 individual information channels are available in the audio spectrum.

Reliable frequency shift method of keying is used. All essential controls such as transmitter output level and receiver input level are included.

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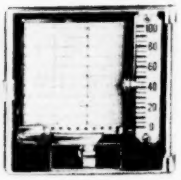
For more information circle **64** on inquiry card.

NEW INSTRUMENTS

fusion pump with no water connection needed, low-loss cold trap, and maker's ultrastable RG-3 ion gage circuit which permits readings down to 2×10^{-9} mm Hg.—*Veeco Vacuum Corp., 86 Denton Ave., New Hyde Park, L.I., N.Y.*

For more information circle **325** on inquiry card.

PRESSURE RECORDERS



New 3" strip chart recording pressure gages, identical in appearance to maker's "Metagraphic" pneumatic recording receivers, have interchangeable plug-in chassis, are available in ranges from 0-3 psi to 0-60 psi. Elements in various ranges are offered in Ni-Span C, beryllium copper, and phosphor bronze. Various models for recording and/or indicating one and/or two pressures. Choice of chart speeds and of pneumatic or electric chart drives.—*The Bristol Company, Waterbury, Conn.*

For more information circle **326** on inquiry card.

ABSOLUTE PRESSURE SWITCH

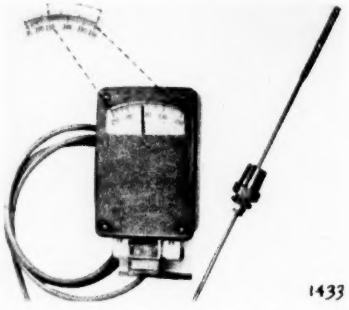
New subminiature Model RR-30, for use under vibrations up to 1000 cps 7 *G*, and temperatures from −85°F to 200°F, weighs 2 oz; comes in nominal pressure settings from $5\frac{1}{2}$ psia to $23\frac{1}{2}$ psia.—*Newark Controls Co., 15 Ward St., Bloomfield, N. J.*

For more information circle **327** on inquiry card.

temperature and humidity

INDICATING TEMPERATURE TRANSMITTER

New Model 44 pneumatically transmits temperature measurement in ranges from 100°F to 600°F, with



spans of 100 F° and 200 F°. Feature: expansion of upper (more sensitive) portion of vapor pressure thermal curve over a $4\frac{1}{2}$" scale, whence 30% to 50% greater output pressure change per unit temperature change.—*The Foxboro Co., Foxboro, Mass.*

For more information circle **328** on inquiry card.

TEMPERATURE CONTROLLER

New E95 explosion-proof temperature controller features head compensation effective from −65° to 160°F, and calibrated setting dial. Models are available with spans of 100 F° or 200 F° between limits of −150°F and 650°F, with on-off differentials of about 1 F° and 2 F°.—*United Electric Controls Co., 79 School St., Watertown, Mass.*

For more information circle **329** on inquiry card.

TEMPERATURE CONTROLLER

New mercury-actuated Model MFS features accuracy of 0.5% of scale range; is available in ten different

scale ranges within extreme limits of −30°F to 1100°F. Exclusive "Accu-Vision" minimizes error.—*The Partlow Corp., New Hartford, N. Y.*

For more information circle **330** on inquiry card.

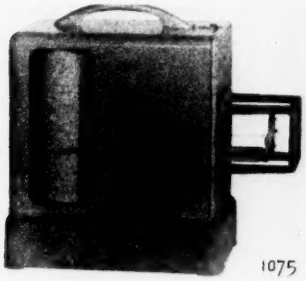
NEEDLE-TYPE PYROMETER

New Pyrominor yields quick reading of inside temperature of rubber, plastics, etc.; has stainless-steel hypodermic-needle-form rapid-response thermocouple. Standard ranges 0-200°F, 0-400°F, 0-100°C, 0-200°C. A thermometer for ambient temperature correction curves around the scale.—*EPIC, Inc., 154 Nassau St., New York 38, N. Y.*

For more information circle **331** on inquiry card.

HUMIDITY RECORDER

New Microhygrograph records minute fluctuations in relative humidity on a 24-hour 12" x 6" chart. Readings

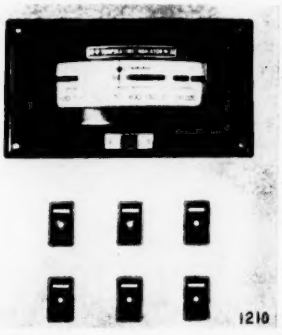


to less than 1% RH are possible. Range 15% to 95% RH at 32 F to 130 F.—*Serdex, Inc., 91 Cambridge St., Boston 14, Mass.*

For more information circle 332 on inquiry card.

RESISTANCE THERMOMETER

New Electronic Resistance Thermometer indicates, at one central location, temperatures of remote check



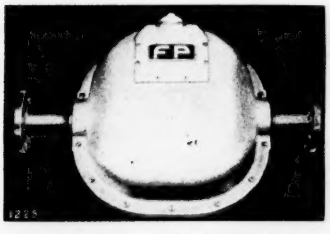
points throughout a building's heating and air conditioning system.—*Barber-Colman Co., 1360 Rock St., Rockford, Ill.*

For more information circle 333 on inquiry card.

flow-rate, volume

MAGNETIC FLOWMETER

New Magnetic Flowmeter for "difficult" liquids such as acids and slurries features manual adjustment



for setting any desired flow-rate at full-scale (1" meter from 3 to 40 gpm at full-scale; ½" meter as low as 1 gpm); readings unaffected by voltage changes between 90 and 125 v

314 VISUAL RECORDER—The bird is a flutter. To find the bug, first find his hole. This can be done in the greenhouse with Tally's new Visual Recorder, which plots on Faxpaper the graph of twelve selected flight-test variables at 15 times the speed of data acquisition. Later, Tally's **201 Plotter** could plot the computer's finding to further spotlight performance. These are but two of Tally's developments available to you as the result of successful special work for others. Write for details about products or skills.

Model 314 Visual Recorder

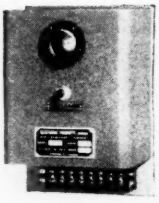
TALLY
REGISTER CORPORATION

Department 110
5300 14th Avenue N.W.
Seattle 7, Washington

For more information circle **65** on inquiry card.

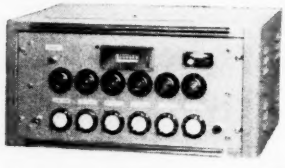
Post Decitron
electronic products

Model SD-1



Versatile, low cost counter — will tabulate up to 50 units per second in continuous operation. Available with totalizer . . . can be placed several hundred feet from switch contacts.

Model P6



Preset electronic counter—up to 5,000 units per second — direct readout totalizer. Will "batch count" any quantity from 1 to 1,000,000. Can be coordinated to secondary circuit for "kicking" devices, etc.

Model LF

Lineal Footage device — can be used with other "Decitron" electronic units to accurately measure and tabulate lengths of wire, rope, sheet stock, paper, cloth, etc. May be used with digital readout printer or visual totalizer on counter.

POST ELECTRONICS
Division of Post Machinery Co.
158 Elliott St., Beverly, Mass.

Decitron

POST ELECTRONICS
Division of Post Machinery Co.
158 Elliott St., Beverly, Mass.

☐ Send literature on Model_____
☐ Please send name of nearest representative

Name_____
Company_____
Address_____
City_____ State_____

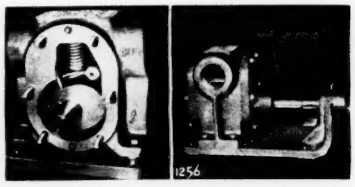
For more information circle **66** on inquiry card.

and frequency changes between 55 and 65 cps; flow can be measured in either direction.—*Fischer & Porter, 458 Jacksonville Road, Hatboro, Pa.*

For more information circle **334** on inquiry card.

METERING PUMP

New Twin-Lobe Rotary Positive Displacement Pump features extremely high operating efficiency, metering

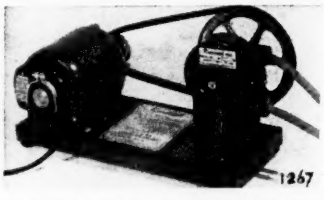


accuracy and suitability for products from gases to viscous pastes. Four models handle pressures up to 200 psi and capacities up to 56 gpm.—*Manton-Gaulin Mfg. Co., 44 Garden St., Everett 49, Mass.*

For more information circle **335** on inquiry card.

ABRASIVE-LIQUIDS PUMP

New pump is said to handle all types of abrasive solutions and slurries with minimal maintenance.

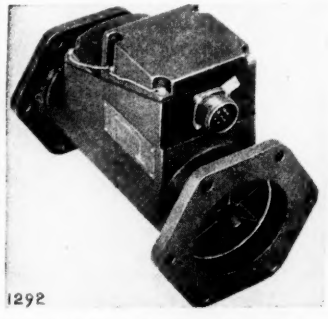


Intake and outlet are one continuous flexible tube exposed to action of a rotary squeegee. Tubing material is selected to suit solutions being handled.—*The Randolph Co., 1018 Rosine St., Houston, Texas.*

For more information circle **336** on inquiry card.

FUEL MEASURING SYSTEM

New Airborne Fuel Measuring System uses maker's turbine flowmeter with new carrier method of signal



generation, whence immunity to vibration and electrical noise interference.—*Waugh Engineering Co., 7842 Burnet Ave., Van Nuys, Calif.*

For more information circle **337** on inquiry card.

position, vibration

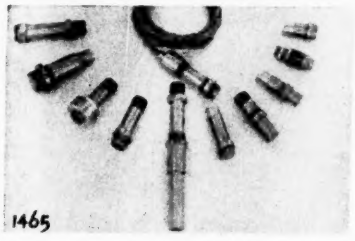
PROXIMITY COIL FOR NON-MAGNETICS

New proximity coil converts into electrical output the motion of non-magnetic as well as magnetic materials. It has an entirely non-metallic housing comprising Nylon liner, Bakelite bobbin and Bakelite shell. Zinc and lead parts passing through this coil actuate control relay. Sensitivity is controlled by adjusting a screw.—*Automatic Timing & Controls, Inc., King of Prussia, Penna.*

For more information circle **338** on inquiry card.

PROXIMITY PICKUPS

New line of Pickup Coils, for converting mechanical motion into electrical output without contact, com-



prises: (1) inductance coils for use with rotating-magnetic-field devices, (2) reluctance coils in which a pulse is induced when magnetic material passes nearby; (*a*) high-temperature units for use up to 850 F without special cooling and an air-cooled unit for use up to 1000 F, (*b*) low-temperature units that withstand thermal shock down to −150 F.—*Potter Aeronautical Corp., Route 22, Union, N. J.*

For more information circle **339** on inquiry card.

VIBRATION PICKUP

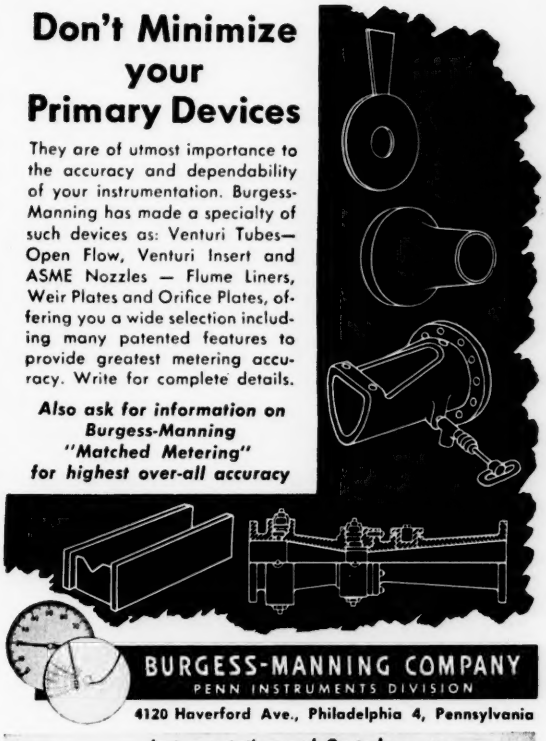
New permanently-sealed moving-coil-type Dynavolt is available in a wide range of stock sizes; resonant frequencies from 7 to 80 cps (whence its possible use as a displacement, velocity or acceleration pickup); outputs as high as 1 volt/inch/second with critical damping; coil resistances from 125 to 1000 ohms. Extremely rugged construction.—*Mandrel Industrial Instruments, P.O. Box 13243, Houston 19, Texas.*

For more information circle **340** on inquiry card.

Don't Minimize your Primary Devices

They are of utmost importance to the accuracy and dependability of your instrumentation. Burgess-Manning has made a specialty of such devices as: Venturi Tubes—Open Flow, Venturi Insert and ASME Nozzles — Flume Liners, Weir Plates and Orifice Plates, offering you a wide selection including many patented features to provide greatest metering accuracy. Write for complete details.

Also ask for information on Burgess-Manning "Matched Metering" for highest over-all accuracy



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For more information circle **67** on inquiry card.

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Valve Capacity and Cv	Sizing
Flow Characteristics	Positioners
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A complete home-study text and course, with 459 multiple-choice test items on basic electronic circuitry.

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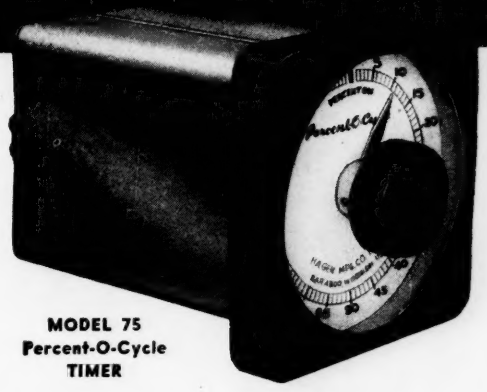
HAGEN

PERCENT OF CYCLE



MODEL 75
Percent-O-Cycle
TIMER

SAVES SPACE, CUTS POWER LOSS

Only 3-1/2" square at the face, 4-5/16" deep, the Hagen Percent-O-Cycle Timer is a worthwhile substitute for power-wasting rheostats and variable voltage equipment on many applications. Snap action contacts, operated by synchronous motor drive, permit this unit to handle loads up to 25 amps at 125 volts, 60 cycles. Current input into electrically heated furnaces, etc., may thus be efficiently controlled by turning current on for whatever percent of the time cycle is required.

REPEAT ACCURACY 1/10 OF 1%

Easy to read dial makes it possible to set timer to 1/4% of desired setting. "ON" time adjustable from 1-1/2% to 98-1/2% of total time cycle. Standard time cycles: 15, 30 and 60 seconds; 4, 15, 30, and 60 minutes; 2, 4, and 8 hours.

WIDE FIELD OF APPLICATIONS

Stokers, Pumps, Blowers, Lubrication Systems, Dryers and Dehumidifiers are some of the other uses suggested by the Percent-O-Cycle Timer.

Send for new HAGEN Bulletin 1360.

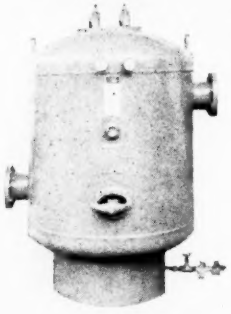
Write Hagen Mfg. Co., Inc. Moline, Illinois, Dept. IA-258.

For more information circle **68** on inquiry card.

AUTOMATIC REMOVAL

MOISTURE VAPOR HUMIDITY

FROM COMPRESSED AIR



Van-Air® DRYER

Unique in moisture-control, Van-Air Dryers do more than trap condensed liquids from compressed air lines. They remove vapor-humidity to *LOW DEW POINTS* besides eliminating water and solid impurities from raw compressor air.

Van-Air Dryers eliminate elusive trace vapors that condense at line-extremity temperatures and cause untold product spoilage, instrument failure and operational down-time. Where air must be of clean, dry, instrument quality as in automation, product finishing, processing foods, chemicals, plastics, etc., these Dryers are proving highly efficient—*AND*, they work for pennies instead of dollars. Available in many capacities up to 5000 SCFM and pressures up to 3000 psi. Van-Air Dryers are used by hundreds of plants from coast to coast.

When air-line moisture is a problem in your plant, Van engineers will be glad to help. Write or phone —Erie 3-5556. Meanwhile, ask for useful handbook, "Air, Water and Industry."

SEND FOR BROCHURES OF

Van-Air and Vi-Speed

PNEUMATIC EQUIPMENT

SHOWING UNIVERSAL AIR CYLINDERS, BENCH-TYPE and DEEP-JAW AUTOVISES BENCH and ARBOR PRESSES ENGINEERED FOR AUTOMATION BY

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For more information circle **69** on inquiry card.

speed

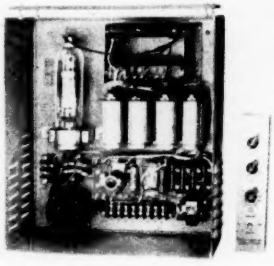
ELECTRICAL TACHOMETER

New five-range fully-transistorized Electronic Tachometer measures speeds from 0.1 to 10,000 rpm; features contactless pickup: radial lines scribed on a rotating disc interrupt light beam to produce 360 pulses per revolution. Breakaway torque and inertia are extremely small.—*Southwestern Industrial Electronics Co., 2831 Post Oak Road, Houston 19, Texas.*

For more information circle **341** on inquiry card.

MOTOR CONTROLLER

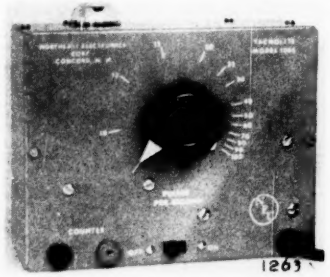
New C60 operates a ¾-hp shunt-wound motor on 220-230 v 50-60-cps single phase; speed from 0 to 2400 rpm, with full torque from 300 to 2400 rpm. Controller embodies acceleration control, reverse, coarse and fine speed adjustment.—*Gerald K. Heller Co., 1819 Industrial Rd., Las Vegas, Nev.*



For more information circle **342** on inquiry card.

STROBE LIGHT SOURCE

New Model 1065 Tacholite provides a variable-frequency stroboscopic light source: 10 to 100 pulses per second. For precision measurements, an output is provided to drive a counter.—*Northeast Electronics Corp., Concord, N. H.*



For more information circle **343** on inquiry card.

MACHINE SPEED CONTROLLER

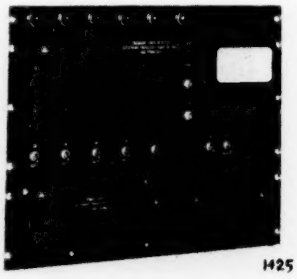
New Model 3440 over/under magnetic-amplifier (tubeless) speed-control relay for lower surface speeds is especially recommended as a safety device for machine tool builders; is designed for use with a magnetic pick-up mounted near a rotating gear. Entire chassis fits in a commercially available JIC approved wiring box. —*Electro Products Labs., Inc., 4500 N. Ravenswood Ave., Chicago 40, Ill.*

For more information circle **344** on inquiry card.

time and sequence

ELECTRONIC PROGRAM TIMER

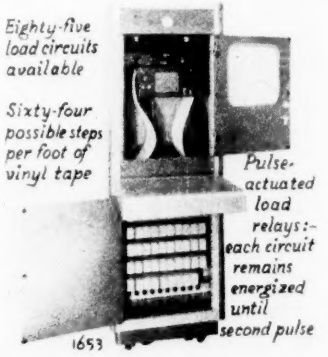
New Model PT-157 will independently control sequence and timing of several related operations of a machine or process; permits rapid and accurate change of time settings controlling each operation (no cam adjustments). Unit shown controls six operations; others available for more or fewer.—*Electronic Processes Corp. of California, 2190 Folsom St., San Francisco 10, Calif.*



For more information circle **345** on inquiry card.

SEQUENCE CONTROLLER

New Punched Tape Programmer commands up to 85 circuits through steps or functions whose total number depends on total length of continuous-loop tape. It has indicating lights for steps in program and pilot lights for each load circuit. Programs are changed rapidly by changing tapes.—*Industrial Timer Corp., 1407 McCarter Highway, Newark 4, N. J.*


Eighty-five load circuits available
Sixty-four possible steps per foot of vinyl tape
Pulse-actuated load relays:- each circuit remains energized until second pulse
1653

For more information circle **346** on inquiry card.

telemetering

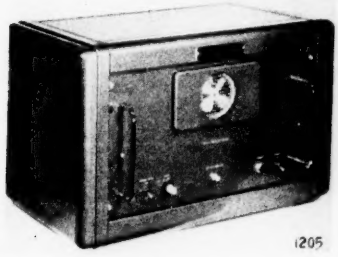
3 KC CARRIER SYSTEM

New single-channel portable (10-lb) Model PCS-1, designed for use with variable-reluctance pickups including maker's pressure and acceleration pickups, includes a 3-kc oscillator to excite the pickup coils, a full-wave transistor switch demodulator and a panel instrument to indicate pickup output. Dimensions 3 x 6 x 7"; power requirement 35 watts at 105-125 v, 50-60 cps. Auxiliary: Model F-1 Filter can be plugged into basic carrier unit to provide a suitably filtered output for driving 'scopes, oscillographs, pen recorders, etc.—*Northam Electronics, Inc., 2420 N. Lake Ave., Altadena, Calif.*

For more information circle **347** on inquiry card.

MULTICODER

New G-Series Multicoder is a supersensitive low-level multiplexing and coding instrument "expected to



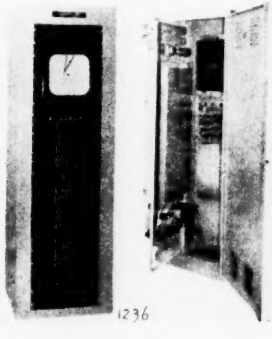
1205

open new ranges in telemetering and data acquisition applications"; enables sampling up to 88 data channels in pulse-width form in the 15-mv range. Output can be recorded on mag tape, transmitted over a line, or used to modulate a transmitter.—*Applied Science Corp. of Princeton, P. O. Box 44, Princeton, N. J.*

For more information circle **348** on inquiry card.

PWS SUPERVISORY SYSTEM

New low-cost pulse-width-selection system for remote supervisory systems permits 430 on/off control functions plus 430 supervisory functions to be handled by a single trans-



1236

The "MiniMite" Portable Pyrometer Indicator gives you laboratory accuracy—in a rugged, versatile instrument. You can use it dependably for a wide range of temperature measurement, calibration and test purposes. Carry it around and set it up wherever you need it. Heavy use won't impair its performance or accuracy.

Temperature Measurement

When connected to a thermocouple the "MiniMite" will measure temperature directly. Use it for laboratory work, emergency operation, or as a substitute for instruments under repair. It's also ideal for a wide variety of research and test work. Automatic cold-junction compensation is built-in.

Calibration

You can use the "MiniMite" to calibrate thermocouples—also both potentiometer and millivoltmeter-type instruments. For calibrating millivoltmeters, T-E offers a portable sister instrument, the "MilliMite," as a variable source of D.C. potential and resistance.

Scale Range

Despite the "MiniMite's" small size, individual ranges on its double-range scale are almost 24" long. A choice of 19 different range combinations covers temperatures from —300°F. to +3200°F. for Copper-Constantan, Iron-Constantan, Chromel-Alumel and Platinum-Rhodium-Platinum—and millivolts from —6.2 to +62. Accuracy is ½ of 1% of scale range.

Convenience

The "MiniMite" measures only 4" x 5" x 6" and weighs under 4 lbs. It will function in either horizontal or vertical position. Widely spaced graduations permit easy, accurate readings. Cold-junction compensation can be cut in or out by a single switch.

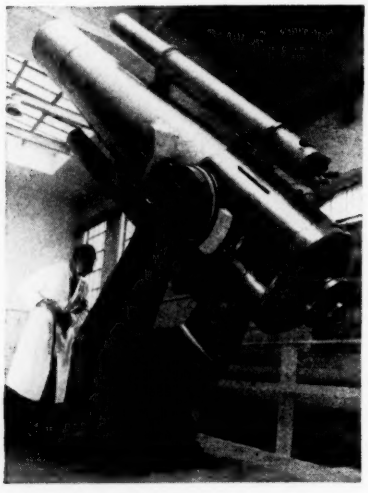
Write For Bulletin 64-F.

Thermo Electric CO., INC.
SADDLE BROOK, NEW JERSEY

In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

For more information circle **83** on inquiry card.

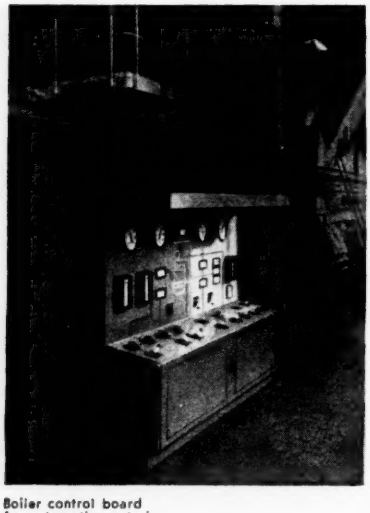
For More Than 85 Years



Schmidt-Telescope for an University-observatory

the Askania-Werke Berlin-Friedenau, have manufactured precision instruments for astronomical, geodetic, and geophysical purposes which have proved their value in all countries of the world.

For More Than 35 Years



Boiler control board for automatic control

measuring instruments and controllers for power and process industries have been included in the extensive range of Askania-Werke manufactures. In their special workshops the

Jet — Pipe Regulator

has been invented for all tasks of control. i. e. for pressure, flow-mixture-temperature-control etc. and is now in use all over the world.

Today's

controllers produced by the Askania-Werke are of all types,

electric • electronic

hydraulic • pneumatic

The range of *Scientific Instruments* has also been extended considerably. Many of these various instruments are now being used in research work carried out during the *International Geophysical Year*.

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For more information circle **72** on inquiry card.

NEW INSTRUMENTS

mitter at main station and remote slave units, over a single carrier; can be used as a two-way system for either control or supervision only; is especially adaptable to water, gas, pipeline, and petroleum processing systems.—*Hammarlund Mfg. Co., Inc.*, 460 *W. 34th St., New York* 1, *N. Y.*

For more information circle **349** on inquiry card.

nucleonics

SCINTILLATION DETECTOR

New Scintillation Transducer maximizes pulse height and resolution; comprises maker's high-clarity thallium-activated sodium-crystal integrally packaged with a standard 5" photomultiplier tube. Assemblies are available in any crystal length up to 4"; come housed in over-all mu-metal magnetic shields and complete with preamplifiers. Crystals can additionally be provided with truncated conical ends, drilled wells, or other desired configurations.—*Levinthal Electronic Products, Inc., Stanford Industrial Park, Palo Alto, Calif.*

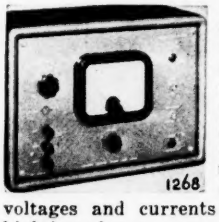
For more information circle **350** on inquiry card.

SCINTILLATION DETECTOR + PULSE HEIGHT FEATURE

New P-200C extends usefulness of P-20B Scintillation Detector to the field of pulse height analysis. With new switch in "spectrometer" position, output pulses of photomultiplier tube can be fed directly to a linear amplifier and its associated pulse analysis circuitry. ★To improve spectral resolution and reduce scatter for pulse height analysis, larger crystals with unshielded crystal holders and without lead crystal package liner have been added to available accessories.—*Tracerlab, Inc.*, 1601 *Trapelo Rd., Waltham, Mass.*

For more information circle **351** on inquiry card.

ELECTROMETER

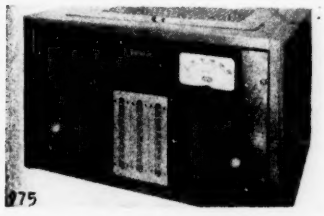


New Model 33B Electrometer for nuclear and x-ray applications is said to be exceptionally stable for measurement of small direct voltages and currents derived from high-impedance sources. Five input ranges from 0-10 mv to 0-1 v (with available adapters 10^{-6} and 10^{-10} amp and 5×10^{15} megohms); output 1 ma full-scale on all ranges; zero drift not over 0.1 mv in 12 hours; input resistance 10^{13} ohms.—*Instrument Div., Robertshaw-Fulton Controls Co.*, 2920 *N. Fourth St., Philadelphia* 33, *Pa.*

For more information circle **352** on inquiry card.

DECADE SCALER

New Model DS-1A Candid Decade contains a continuously-variable high-voltage power supply for operating



all basic nuclear detectors. **Features:** no counting errors; 3 plug-in type decade strips with counting rate up to 10^6 cpm; counting periods controllable by built-in preset timer to an accuracy of 0.2 sec in 55 min.—*Nuclear Measurements Corp.*, 2460 *N. Arlington Ave., Indianapolis* 18, *Ind.*

For more information circle **353** on inquiry card.

RADIATION SURVEY METER

New Model AGB-10KG-SR ionization chamber type for beta-gamma surveys has logarithmic response, cov-

ers from 0.01 mr/hr to 10,000 r/hr in only three ranges.—*Jordan Electronics Co.*, 3025 *W. Mission Rd., Alhambra, Calif.*

For more information circle **354** on inquiry card.

laboratory equipment

MICRO BALANCES

Four new quartz helix micro balances with large load ranges (0-2.5, 0-5, 0-10 and 0-20 grams) are useful for surface studies, for observing weight changes during chemical operations, absorptions and dehydrations, etc. They can be operated in a vacuum, in controlled atmosphere, and at temperatures ranging from below freezing to above boiling.—*Microchemical Specialties Co.*, 1834 *University Ave., Berkeley* 3, *Calif.*

For more information circle **355** on inquiry card.

SEMI-AUTOMATIC BALANCE

New one-pan analytical balance for weighings from 0.1 milligram to 200 grams features new two-beam con-

struction: all weighings from 1 to 200 g are made within 1 g on a "rough-weighing" beam and two amber lights indicate which way the weight control knob should be turned; all weighing adjustments from 0.1 mg to 1 g are made on fine-weighing beam and are completely automatic. —*Torsion Balance Co., Clifton, N. J.*

For more information circle **356** on inquiry card.

RESEARCH MICROSCOPE

New Model R phase-contrast microscope features extreme rigidity; permanently horizontal mechanical focusing stage with verniers and inclined eye tube. Coarse and fine adjustments are accomplished with hand resting on table and with "absolute freedom from back-lash and lost motion." —*Karl Heitz, Inc.*, 480 *Lexington Ave., New York* 17, *N. Y.*

For more information circle **357** on inquiry card.

STIRRING PADDLE

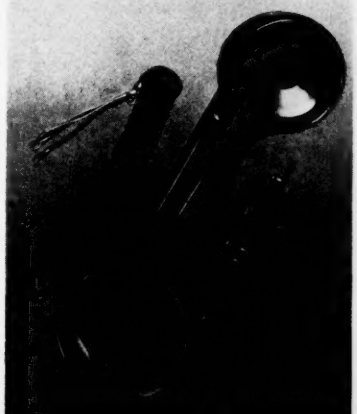
New "Impelator" combines centrifugal force, suction-and-shearing action, and counter-whirl, creating an efficient intense mixing zone, promoting high-velocity flow through entire vessel, maximizing dispersion and minimizing particle size.—*Palo Laboratory Supplies, Inc.*, 81 *Reade St., New York* 7, *N. Y.*

For more information circle **358** on inquiry card.

EXPLOSION-PROOF BALANCE

New modification of Right-A-Weigh one-pan substitution-weighing balance is for use in Class 1, Group D, hazardous locations. Switch, transformer, and light for projection system are contained in an Underwriters-ap-

For industrial applications



Stromberg-Carlson
"Push-to-talk"
HANDSETS

You'll find many valuable uses for Stromberg-Carlson's "Push-to-talk" telephone handsets in your day-to-day operations. These instruments feature switch assemblies with various spring combinations mounted in the handles, actuated by a rocker-bar lever. A few typical applications:

- **Push-to-talk** and **Push-to-receive:** for two-way radio communication.
- **Push-to-open** and **Push-to-close external circuit:** for use with dictating machines and in remote control operations.

You have a choice of two types of handset: No. 28, which is the standard model; and No. 29, a special high-gain, high-efficiency handset with Western Electric type receiver and transmitter. Available with either coiled or straight cord.

For complete technical details on these handsets and other Stromberg-Carlson telephones and components for industrial use, send for Bulletin T-5005. Write to:

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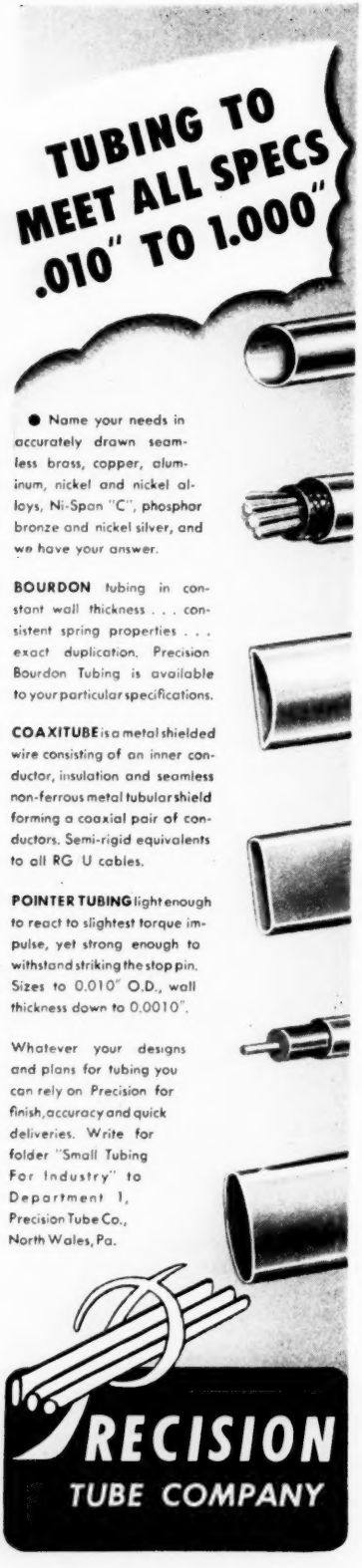
For more information circle **73** on inquiry card.


TUBING TO
MEET ALL SPECS
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COAXITUBE is a metal shielded wire consisting of an inner conductor, insulation and seamless non-ferrous metal tubular shield forming a coaxial pair of conductors. Semi-rigid equivalents to all RG U cables.
POINTER TUBING light enough to react to slightest torque impulse, yet strong enough to withstand striking the stop pin. Sizes to 0.010" O.D., wall thickness down to 0.0010".
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For more information circle 74 on inquiry card.

NEW INSTRUMENTS

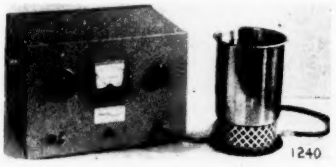
proved explosion-proof aluminum housing mounted outside balance case. Electrical system is all outside balance where it can be inspected easily, and heat from lamp and transformer does not affect weighings. All weights are built into balance; are operated by knobs outside case, and totalled on an eye-level counter. Values from 0.1 mg to 100 mg are quickly read on projected scale.—*Ainsworth Co.*, 2151 *Lawrence St., Denver 5, Colo.*

For more information circle **359** on inquiry card.

shop equipment and supplies

ULTRASONIC CLEANER

New one-gallon portable ultrasonic cleaning unit is effective also for degreasing, decontamination, excess

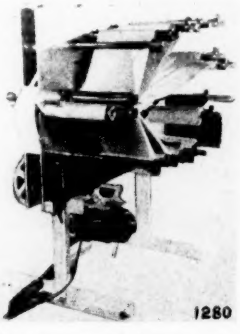

1240

flux removal, emulsifying, etc. Generator features timer, tuning knob and visual control, output 50-watt average with 200-watt peak. Stainless steel tank equipped with three transducers can handle production jobs on a continuous basis.—*Hermes Sonic*, 13-19 *University Pl., New York 3, N. Y.*

For more information circle **360** on inquiry card.

CAPACITOR WINDING MACHINE

New capacitor winding machine is said to be "the least expensive machine on the market today for winding such large capacitors up to 13" in length"; has counters for linear measuring as well as revolutions; can accommodate 16 rolls for either inductance or insulation material.—*Taper Micrometer Corp.*, 100 *Grove St., Worcester, Mass.*


1280

For more information circle **361** on inquiry card.

LIQUID DETERGENT FOR ULTRASONIC CLEANING

New No. 175 ultrasonic liquid detergent speeds cleaning of such difficult-to-clean objects as lenses, precision parts, ball bearings and clockworks.—*Acoustica Associates, Inc.*, 26 *Windsor Ave., Mineola, N. Y.*

For more information circle **362** on inquiry card.

MAGNETIZERS

New MF-200 and MF-300 magnetizers for permanent magnets are mobile plug-in units. Coils are wound

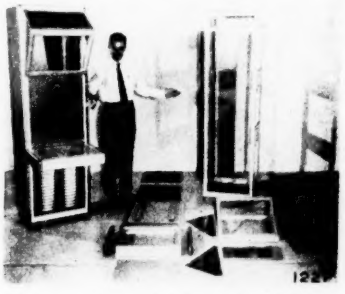
1229

directly on steel structure over only a film of Mylar insulation, whence improved heat dissipation, and comfortable operating temperatures.—*Magnetic Materials Section, General Electric Co., Edmore, Mich.*

For more information circle **363** on inquiry card.

BUILDING-BLOCK CABINETS

Newly expanded and improved Emcor Modular Enclosure System comprises a new line of vertical


1227

cabinets, completely redesigned to provide up to 200% more load carrying capacity.—*Elgin Metalformers Corp.*, 630 *Congdon Ave., Elgin, Ill.*

For more information circle **364** on inquiry card.

ENCAPSULATION MATERIAL

New Epoxy E-Form preformed pellets, for encapsulation of electronic components, are a stable, dry blend of epoxy resin and hardener, combined into the shape of an easily-handled preform whose size and shape can be varied to serve as a metered charge.—*Epoxy Products, Inc.*, 137 *Coit St., Irvington, N. J.*

For more information circle **365** on inquiry card.

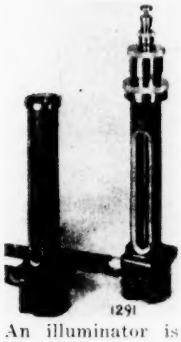
CERAMIC CEMENT FOR HIGH-TEMPERATURE PICKUPS

New Allen PBX High Temperature Ceramic Cement retains its high electrical resistivity and mechanical strength at temperatures up to 2000°F; is easily applied to aluminum, steel and titanium parts which require ceramic bonding. Used in high-temperature strain gages, thermocouple assemblies, piezoelectric pickups, etc., bondings maintain their insulating properties at all operating temperatures and eliminate an important source of error.—*High Temperature Instruments Corp., Bala-Cynwyd, Penna.*

For more information circle **366** on inquiry card.

dimensional gaging and inspection

MICROMETER WATER LEVEL



Newly improved Watts Micrometer Water Level, for leveling or aligning jobs to 0.0005", features interchangeable jewel needle point on micrometer dipper. Two or more micrometer heads can be used simultaneously for multiple-point leveling systems. An illuminator is available.—*Engis Equipment Co., 431 S. Dearborn St. Chicago 5, Ill.*

For more information circle **367** on inquiry card.

HEIGHT GAGE

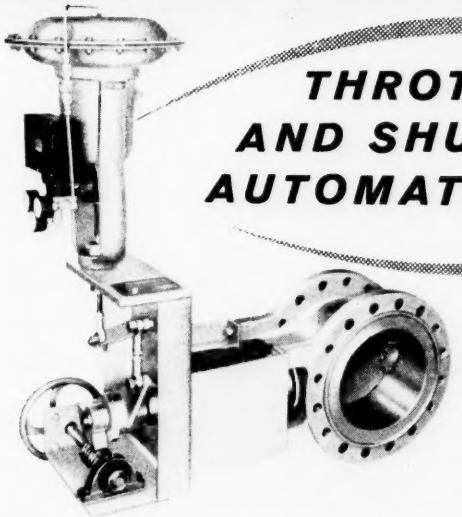
New Tumico Optic Vernier Height Gage, said to be "revolutionary in design," quickly reads to fractions of 0.001" by employing glass scale and glass vernier scales, on which scale and vernier lines are machine-divided and etched to be read from rear of gage. Curved chrome reflector behind glass scale diffuses light and shows scale, vernier lines and numbers in sharp relief, obviating need of magnifiers and auxiliary lights. Normal room light will provide clear visibility of entire scale, matching vernier lines and numbers "superior to all methods tried thus far." Double-length vernier is 2.450" long and adjustable.—*George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.*

For more information circle **368** on inquiry card.

GAGING SYSTEM

New L Series C162 Autocorrector assures that each workpiece is gaged while immobile for at least a split second. An accelerator handles each piece at twice feed velocity so that

ROCKWELL *Butterfly* VALVES



THROTTLE AND SHUT OFF AUTOMATICALLY

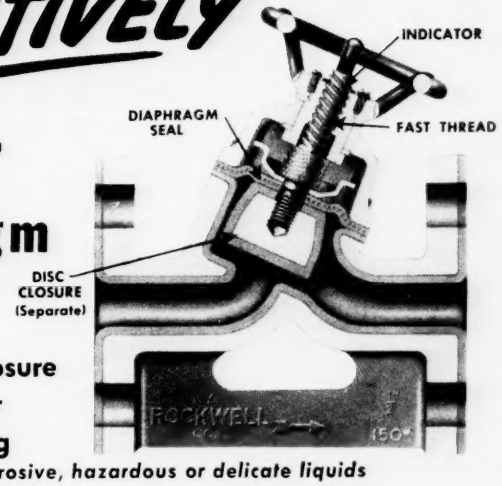
W. S. Rockwell 12" heavy duty butterfly valve of cast steel and stainless steel construction for handling refinery recycle gas at 265 psi and high temperature; provided with heat radiating fins, air actuator, valve positioners, declutching mechanism and emergency handwheel.

No matter what the pressure, temperature or nature of fluid, with Rockwell Butterfly Valves you can get precise, automatic regulating, throttling and shut-off.

Made in all sizes to 144" in any metal (or rubber-covered for corrosion resistance and/or drop-tight closure), or in stress seal design for extremely high temperatures. These valves may be equipped with pneumatic, hydraulic or electric operators for direct or remote control. Manual control also available.

CLOSES and SEALS *POSITIVELY*

"D-D" Diaphragm Valve



Disc for Positive Closure
Diaphragm for Positive Sealing

Ideal for corrosive, hazardous or delicate liquids and slurries; water, air, gas; vacuum service.

- No packing gland to leak. Mechanism not exposed.
- Oversized ports; high capacity; low pressure drop. Largest capacity of any diaphragm type valve.
- Self-draining in horizontal position.
- Lower handwheel torque and fewer turns to close.
- Lower thrust for automatic operation.
- Body of any metal or with any lining.
- Sizes ½" to 6".

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For more information circle **75** on inquiry card.

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Norwood Ave., Cincinnati 12, Ohio

Mfrs. of Industrial Laboratory Recording and Dial Thermometers

For more information circle **76** on inquiry card.

NEW INSTRUMENTS

necessary time for a proper measurement can be taken without pile-up. New system uses capacitance principle enabling direct integration with existing electrical conditions. Guaranteed accuracy 0.00004". ★ Special recorder developed for use with C162 makes a series of dots or perforations; shows rate of wheel wear, or trend and pattern of form errors (taper, etc.) or a form pattern on continuous stock. Feedback leads from the gage can be used for machine corrections or shutdown on limits.—*Electro-Autosizing Machine Div., Industrial Gauges Corp.*, 154 *The Plaza, W. Englewood, N. J.*

For more information circle **369** on inquiry card.

mechanical testing

FATIGUE TESTERS

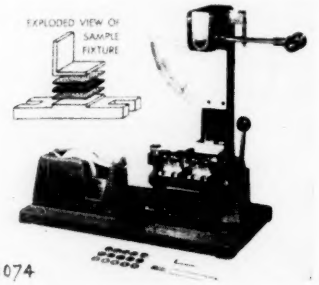
Six new fatigue-testing machines provide both high-force and high-amplitude loading stations; offer

widest possible range of fatigue analysis tests at both room and high temperatures; require no special foundations. Loads range from 50 lb (lowest capacity in smallest machine) to 120,000 lb (highest capacity of largest). Multiplying fixtures enable capacity of each machine to be increased five times (to 600,000 lb in largest).—*Baldwin-Lima-Hamilton Corp., Philadelphia 7, Pa.*

For more information circle **370** on inquiry card.

INTERNAL BOND TESTER

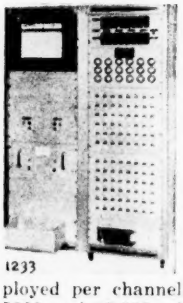
New Model B is for testing gummed and laminated paper, and by those employing paper laminated with other



materials. Internal strength of paper is evaluated by measuring its resistance to a pendulum which swings against vertical angle of 90° top clamp and splits specimen. Two capacities: 0-0.250 and 0.180-0.500 ft-lb, each with its scale.—*Scott Testers, Inc., 45 Blackstone St., Providence, R. I.*

For more information circle **371** on inquiry card.

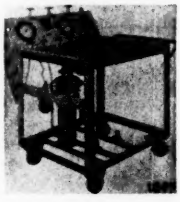
STRAIN GAGE PLOTTER



New Model 220 High Speed Strain Gage Plotter comes as a 48- or 96-channel unit; records 48 channels in 12 seconds and 96 channels in 24 seconds. One or two 60- to 500-ohm resistance strain gage inputs can be employed per channel. Ranges of 2000, 5000 and 10,000 microinches for 5½" graph are available with a gage factor adjustment of 1.6 to 2.2.—*Gilmore Industries, Inc., 5713 Euclid Ave., Cleveland 3, Ohio.*

For more information circle **372** on inquiry card.

HYDRAULIC TEST STANDS

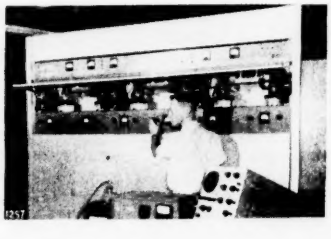


New Series KC-854 air-operated portable test stands for simplified testing of hydraulic components and systems have either one or two outlets. Dual outlet stand can also be supplied with a four-way selector valve to cycle component being tested. Maximum pressures from 3000 to 30,000 psig.—*Kahn and Co., Inc., P. O. Box 516, Hartford, Conn.*

For more information circle **373** on inquiry card.

POWER AMPLIFIERS FOR VIBRATION TESTING

Three new high-rated power amplifiers (7.5, 15 and 22.5 kva) extend frequency and force ranges of vibration test systems for sinoidal and random motion excitation. Their rated

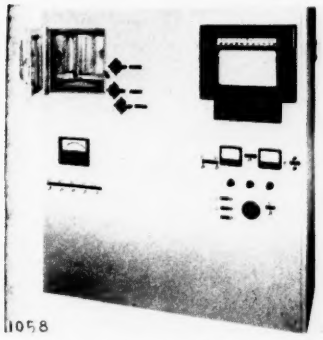


power output is maintained over wide frequency range into any power factor load from 0.2 lead to 0.2 lag. Frequency response ±0.5 db from 5 to 5,000 cps.—*MB Mfg. Co., Div. of Textron Inc., New Haven, Conn.*

For more information circle **374** on inquiry card.

ROOM THERMOSTAT TESTER

New Test Chamber determines sensitivity of room thermostats according to NEMA standards. Tempera-



ture range is 60-80° F. Temperature rate-of-change can be varied from 0 to 40 F° per hour.—*Labline, Inc., 3070 W. Grand Ave., Chicago 22, Ill.*

For more information circle **375** on inquiry card.

electrical testing

FAULT DETECTOR

New Ground Alert instantly detects line-to-ground faults in 440-v 3-phase ungrounded electrical systems; gives both visual and auditory warning. It is available in a stationary type for permanent installation, and a portable type (illustrated). It gives immediate and positive indication of ground faults well before insulation resistance drops to zero. It can be factory-adjusted to indicate any desired minimum resistance to ground from 0 to 7,500 ohms.—*Delta Engineering Sales Co., Box 1403AF, Shreveport, La.*

For more information circle **376** on inquiry card.

TRANSFORMER TESTER

New Knopp Type CTC Current Transformer Comparator determines CT ratio and phase errors simultaneously; features freedom from effects of stray fields, harmonics, and heavy overload test currents. With self-contained ammeter of 1-, 10-, and 20-amp ranges, total burden imposed upon

LOOK CLOSER!

The orifice is tapered, not the tube

New C-Mar Series 5000 Flow Meter Employs Unique TAPOR-FLO® Principle.

This C-Mar Series 5000 area meter differs from conventional "rotameters" in many important ways. Area of opening for flow is varied by an accurately cut and tapered *orifice*, rather than a tapered *tube*. Result: simplified design, easier installation and maintenance, and a number of operating advantages *at no increase in cost*.

True Even Graduations. Exact linear relationship between float movement and flow rate *over entire scale*. Gives true linear output signal with electric transmitter.

"Quick-Out" Flow Tube. To clean or replace flow tube, simply unscrew bottom adapter and pull out flow tube—in a matter of seconds! No need to remove meter from line.

High Stability of Float. Float lines out quickly for reading when flow changes occur. Cycling or "bobbing" is minimized.

Accurate Measurement of Low Flows. Measures flows from 0.0001 to 50 gpm of water (0.0001 to 90 scfm air) with excellent reproducibility of flow readings.

New Series 5000 TAPOR-FLO Meter with Lucite safety shield. Meter has only 12 basic parts, with all identical parts completely interchangeable.

Write for Bulletin 5010. Get full specifications on this completely new meter, including O-ring seals and versatile end fitting design for vertical or side pipe connection. Also covers OPTIONS, such as materials, magnetic read-out, transmission, and tripod mounting.

C-MAR Corporation 35 Euclid Ave., Manasquan, N. J. Phone: CAstle 3-0515

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For more information circle **77** on inquiry card.

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For more information circle **78** on inquiry card.

either standard current transformer or transformer-under-test is less than 0.1 va. Included also is a detector for wrong polarity or other improper transformer connections.—*Knopp Inc., 1307-66th St., Oakland 8, Calif.*

For more information circle **377** on inquiry card.

TEST OSCILLATOR

New Model 25A Test Oscillator, for repetitive test and maintenance operations in telecommunications indus-

1215

try, is battery-operated, features eight pushbutton-selectable frequencies (between 100 cps and 150 kc) and all-transistor circuitry.—*Consolidated Electrodynamics Corp., Alectra Div., 325 N. Altadena Drive, Pasadena, Calif.*

For more information circle **378** on inquiry card.

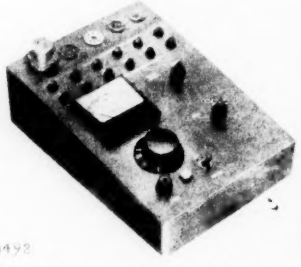
SURFACE RESISTANCE TESTER

New Microhm Meter, specifically designed for making highly accurate surface resistance measurements in microhm range, checks "cleanliness" of aluminum or other sheet material —an essential step in maintaining quality control of spot welding. It reads directly in microhms on 0-75 range and a selector switch cuts in multipliers for 4 additional higher ranges.—*J. W. Dice Co., Englewood, N. J.*

For more information circle **379** on inquiry card.

RELAY TESTER

New Model 15B, for instantaneous go, no-go test for s-p to 6p-dt relays, has coil excitation variable from 6 to



1492

150 v. Set of lights indicates opens, shorts, or intermittent contact operation. Five connector types and adapters permit plug-in of solder-terminal relays.—*Zeus Engineering Co., Inc., 635 S. Kenmore Ave., Los Angeles 6, Calif.*

For more information circle **380** on inquiry card.

DIELECTRIC TEST SET

1243

New Type 50 Breakdown Tester furnishes potentials required for MIL-C-13294A. Output is continuously adjustable from zero to 5 kw at 1000 v or 5000 v rms. Set operates from 220 v rms, 60 cps, single phase, has instantaneous-trip type circuit breaker.—*Industrial Transformer Corp., Gouldsboro, Pa.*

For more information circle **381** on inquiry card.

DC OVERPOTENTIAL TESTER

New Model 3050-5 provides non-destructive qualitative and quantitative dielectric testing, "burn" currents for positive fault identification, effective personnel and equipment protection, and simplicity of operation which permits use by non-technical personnel. Output range 0-50 kv at 0-5 ma; 0-5 20-50 kv voltmeter ranges, 0-50/200/500/2000/5000 microammeter ranges; input 105-125 v 50-60 cps.—*Sorensen & Co., Inc., Beta Electric Div., 333 E. 103 St., New York 29, N. Y.*

For more information circle **382** on inquiry card.

POWER ANALYZER

New Model 1782 features a new tap-changer switch permitting quickly changing current ranges under

1452

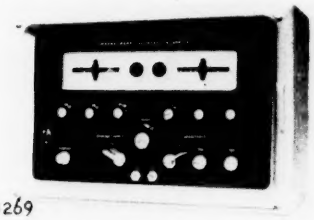
load. Both ammeter and wattmeter have pointer follow-up device for determining maximum inrush current and power, enabling previously-impractical tests.—*Niagara Electrical Instrument Co., 45 Allen St., Buffalo 2, N. Y.*

For more information circle **383** on inquiry card.

electrical and electronic instruments

UNIVERSAL BRIDGE

New Type B221 Wayne Kerr Universal Bridge is a high-precision transformer ratio arm bridge with



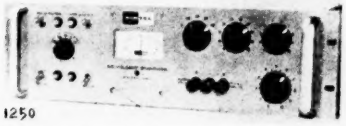
1269

facilities for 2-, 3-, or 4-terminal measurements or impedance or transfer admittance at an operating frequency of 1592 cps (10,000 radians/sec.). Seven capacitance ranges from 0.0002 uuf to 11 uf; seven conductance ranges from 0.1 to 10 $^{-7}$ mhos (10 ohms to 100 megohms); seven inductance ranges from 1 mH to infinity. Two decades and a continuously-variable control indicate independently resistive and reactive terms to four significant figures.—*Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa.*

For more information circle **384** on inquiry card.

DC VOLTAGE STANDARD AND NULL METER

New Model 301R features 0.01% stability, 0.02% accuracy, 0.002% line and load regulation, direct-reading

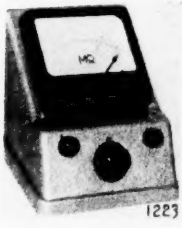


1250

calibrated dials providing instant voltage selection with standard-cell accuracy. Unique chopper-stabilized circuit constantly compares output with an internal standard cell. Power supply output voltage is 1 to 501. Four decaded null meter ranges from 50 v to 50 mv full scale.—*Kin Tel, 5725 Kearny Villa Rd., San Diego, Calif.*

For more information circle **385** on inquiry card.

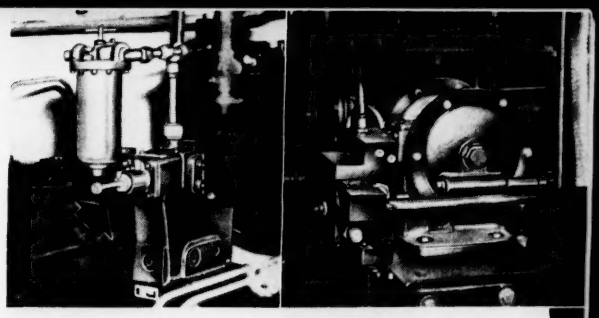
MEGAMEGOHMMETER



1223

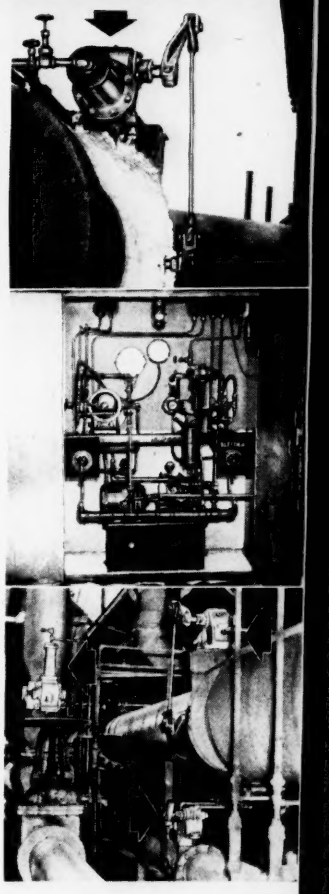
New Knick Teraohmmeter for measurement of impedances up to 10^{16} ohm (with 100 v) features self-balancing measuring bridge which enables taking quick readings when measuring capacity-loaded test objects; is insensitive

FOR
PRESSURE
•
FLOW
•
PROPORTIONING
•
COMBUSTION
•
POSITION



Key Component for those TOUGH CONTROL JOBS

THE ASKANIA JET PIPE RELAY



THE ASKANIA JET PIPE RELAY, nucleus of Askania Controllers for pressure, flow, proportioning, combustion and position, is designed for the TOUGH control jobs. You can depend upon it for the operation of LARGE, HEAVY valves, dampers, engine throttles and other final control elements or those having high thrust requirements.

The Askania Jet Pipe Relay provides double acting positive correcting power which opens and closes the valve without the need of a spring return.

Shown on this page are typical examples of Askania's ruggedly constructed Jet Pipe Control systems used for flow, pressure, proportioning and combustion control applications. Askania Jet Pipe Controllers:

- operate equally well indoors and outdoors—won't freeze
- operate even under the most adverse ambient conditions
- are easily installed
- require minimum maintenance
- give instantaneous response to minute changes in the measured variable

Send for General Catalog which describes and illustrates how Askania Jet Pipe Regulators can be applied to various process applications...shows you the solution to your own tough problems. Write Askania Regulator Company, 268 E. Ontario St., Chicago, Illinois

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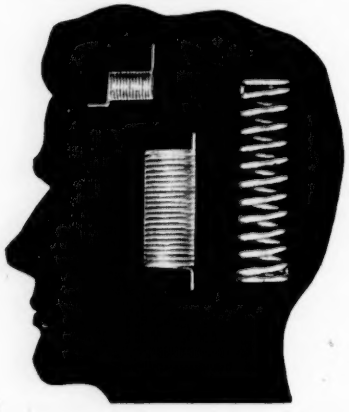
For more information circle **79** on inquiry card.

SPRINGS ON YOUR MIND?



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For more information circle **80** on inquiry card.

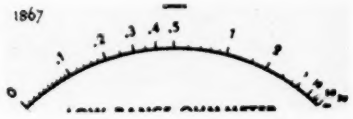
NEW INSTRUMENTS

to voltage fluctuations and independent of tube characteristics and aging. Several models available, each having up to 8 measuring ranges. Can be graduated also for current measurements up to 10^{-14} amp for measuring currents in highly resistive objects, such as phototubes, ionization chambers, etc.—*EPIC, Inc., 154 Nassau St., New York 38, N. Y.*

For more information circle **386** on inquiry card.

LOW-RANGE OHMETER

New Model R-5 features (1) unusual yet simple circuitry and scale-law (illus.) which permit reliable



measurements as low as 0.005 ohm; (2) rugged 800-microampere movement whose full 90° deflection is utilized even on lowest range; (3) line-operated, no tubes, no batteries; (4) only two leads employed; (5) ranges 0-30 and 0-300 ohms.—*Optimized Devices, Inc., Box 38, Gedney Station, White Plains, N. Y.*

For more information circle **387** on inquiry card.

PORTABLE MEGOHMMETER

New battery-operated 500-vdc Model 2030 with regulated transistor power supply is especially suited for measuring insulation leakage wherever power line is inaccessible or where battery operation is more desirable; covers 5 megohms to 10 million megohms.—*Freed Transformer Co., Inc., 1707 Weirfield St., Brooklyn 27, N. Y.*

For more information circle **388** on inquiry card.

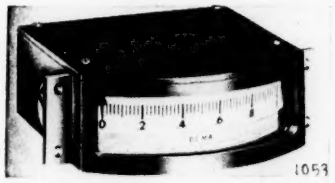
VACUUM-TUBE VOLTMETER

New Model 310 miniature panel-mounted dc VTVM, for incorporation into equipment calling for compactness and dependability, has seven discrete ranges: 0-1 to 0-1000 volts; features simplicity of operation with two controls, Zero Set and Range Switch, on panel. Single- and multiple-range ac and dc versions, ruggedized units, zero-center scales, special ranges, etc., can be provided.—*Pameco, Mill Lane, Waterford, Conn.*

For more information circle **389** on inquiry card.

EDGEWISE INDICATORS

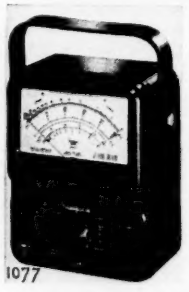
Two new watertight versions of maker's 4½" Indicator Panel Meter: Model 1146 for horizontal mounting



only on flat surfaces such as airplane cowls; Model 1147 for horizontal or vertical mounting on a panel in a vertical plane, can be calibrated for magnetic or non-magnetic panel materials.—*Int'l Instruments Inc., P. O. Box 2954, New Haven 15, Conn.*

For more information circle **390** on inquiry card.

VOLT-OHM-MILLIAMMETER

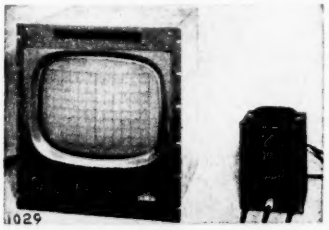


New Series III of 260 VOM embodies many design changes which afford quicker operation, increased sensitivity, higher accuracy, and greater dependability. Among new features: polarity reversing switch, spread-out scales, and a rugged printed circuit.—*Simpson Electric Co., 5200-18 W. Kinzie St., Chicago 44, Ill.*

For more information circle **391** on inquiry card.

LARGE-SCREEN CRI's

New Type 343 (17") and Type 345 (21") cathode-ray indicators employ TV-type CRT's and are designed for



use in conjunction with LF lab-type oscilloscopes but can often be used with other electronic amplifying equipment; are supplied with a cathode-follower adapter for signal transmission over lines up to 100 ft long.—*Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N. J.*

For more information circle **392** on inquiry card.

OSCILLOSCOPES

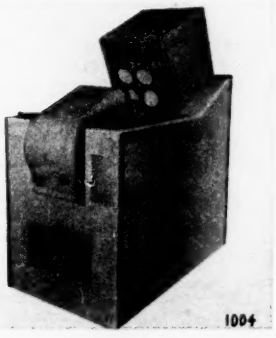
New Model 130BR dc-to-300-kc High Sensitivity Oscilloscope, and Model 150AR dc-to-10-Mc High Frequency Oscilloscope are both designed for 19" rack mounting. Model 130BR

has electrically similar vertical and horizontal amplifiers which have less than 1° relative phase shift at 50 kc and a 1 mv/cm sensitivity. Model 150AR features calibrated sweep magnifications of 5, 10, 50, and 100; any portion of magnified trace can be viewed, and a single sweep provision which permits unlimited sweep expansion. Both have a universal synchronizing circuit; a single preset switch position establishes optimum triggering for nearly all conditions. —*Hewlett-Packard Co., Dept. P, 395 Page Mill Rd., Palo Alto, Calif.*

For more information circle **393** on inquiry card.

CATHODE-RAY RECORDER

New 204-A12 Dynamic Temperature and Strain Recorder features 12 channels of simultaneous data in addition to a calibrated linear time base and zero time on a 10" wide by 31½" long record, for high-speed recording of short-term dynamic phenomena in ballistics, etc.—*Allegany Instrument Co. Inc., 1091 Wills Mountain, Cumberland, Md.*



For more information circle **394** on inquiry card.

DIGITAL VOLT-OHMMETERS

New Transistorized Digital Multimeters complement maker's present line (which utilizes tubes and stepping switches), automatically measure voltage, voltage ratio, and resistance; feature interchangeable plug-in modules which make it possible to start with a basic instrument and progressively add elements to build up a complete, automatic data logging system; "will operate at a higher speed with greater reliability and accuracy than heretofore possible." Readings are in illuminated 1" digits with polarity and decimal point automatically indicated.—*Non-Linear Systems, Inc., Del Mar, Calif.*

For more information circle **395** on inquiry card.

LOW-LEVEL DC VTVM

New Model 110-1 low-level multirange dc VTVM, designed especially for integration into test consoles, can read lower than 200 microvolts on its 3-mv range; features "build-in" package design; is virtually insensitive to

ACCO Helicoid Gage U.S.A.

Nothing but the best in gages for working pressures from 30" vacuum to 10,000 p.s.i.

These details of Helicoid gage design assure longer life and enduring accuracy

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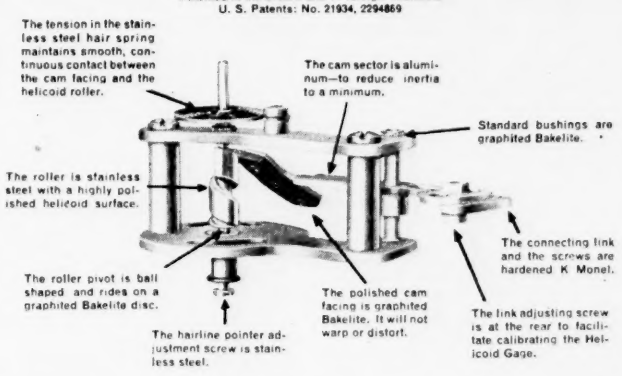
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
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The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped and rides on a graphited Bakelite disc.
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The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
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The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations.

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The Chemical Gage

The Helicoid Chemical Gage has a guaranteed accuracy of plus or minus 1%. It is applicable for working pressures from 30" vacuum to 5000 p.s.i. and temperatures to 400° F. It is particularly suitable for chemicals and other viscous fluids which might clog or corrode a Bourdon tube. Pressure and or vacuum is transmitted directly to the indicating gage element through deflection of a Teflon or Kel F sealing diaphragm.

Tubes built for millions of pressure pulsations

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials—alloy steel, K Monel, stainless steel and phosphor bronze.

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ACCO TRADE MARK

For more information circle **81** on inquiry card.

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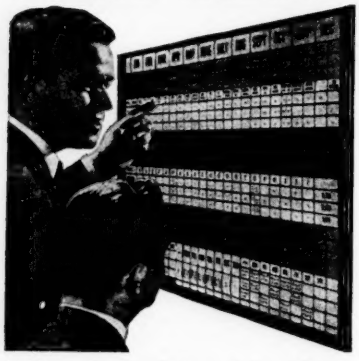

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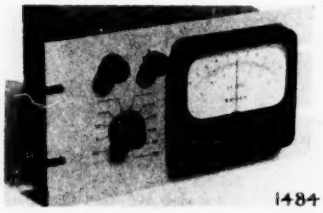
NEW INSTRUMENTS



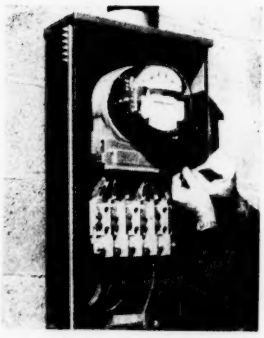
1484

line voltage variations from 80 to 125 v and undamaged by occasional overloads of 100 times full scale setting.—*Trio Laboratories, Inc.*, 4025 *Merrick Rd., Seaford, N. Y.*

For more information circle **396** on inquiry card.

POLYPHASE METER

New V-63, second member of new V-60 polyphase meter family available in Classes 10, 100 and 200, socket or



bottom-connected, has an extended range up to 666.67% of rated current; is designed for use on 3-wire, 2- or 3-phase circuits. ★ New high-capacity polyphase connection box will accept standard polyphase "A" base meters, 6- and 8-terminal, 3-phase.—*Meter Dep't, General Electric Co., Schenectady 5, N. Y.*

For more information circle **397** on inquiry card.

electrical-instrument accessories

COMPUTING GALVANOMETER

New Type 7-370 can perform addition, subtraction, or multiplication of two signals. Moreover, it can measure low-level power in electronic equipment. It is said to be ideal for recording instantaneous watts ($P = EI \cos \phi$), and its phase sensitivity enables user to determine power factor also. It comprises three galvanometer bodies: center body houses moving-coil suspension and mirror; outside bodies house stationary field coils. A static reference mirror is fixed to one outside body for marking zero; in power-measurement application, it marks zero watts.—*Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.*

For more information circle **398** on inquiry card.

SPIRAL BANDED C-R TUBES

New Types 5BGP-(T51P) and 5BHP-(T54P), interchangeable with T51P and T54P single-gun types al-

1426

ready in use, have 5" flat round faceplates, employ both electrostatic focus and deflection, and incorporate post-acceleration by use of a spiral-band resistance winding, whence excellent deflection plate linearity and minimal pattern distortion.—*Electronic Tube Corp., 1200 N. Mermaid Lane, Philadelphia 18, Pa.*

For more information circle **399** on inquiry card.

EVENT RECORDERS

New 4-, 8-, 16-, 24- and 32-channel Event Recorders, for recording "on-off" events, consist of standard recorders used in maker's 150 Series oscillographic recording systems, but with a four-stylus Model 189 Multi-Marker (as shown) in place of EACH conventional galvanometer. Special transistor amplifiers supply Multi-Marker coil power (about 1 w per Multi-Marker coil). Rise-time of combination (amplifier and Multi-Marker) is about 10 milliseconds.—*Industrial Div. of Sanborn Co., 175 Wyman St., Waltham 54, Mass.*

For more information circle **400** on inquiry card.

MEASUREMENT AMPLIFIER

New Model 8110-A Universal Carrier Amplifier achieves exceptionally high gain as well as stable operating

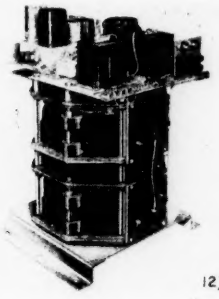
1219

characteristics; attains a sensitivity equal to 1 volt output for 1.5 parts per million change in one leg of a bridge circuit. Depending on pickup installed in bridge, it can measure strain, pressure, temperature, displacement, acceleration or force.—*Edin Co., Inc., 207 Main St., Worcester 8, Mass.*

For more information circle **401** on inquiry card.

VOLTAGE REGULATOR

New Type EM10018 Stabiline Automatic Voltage Regulator extends life and reliability of high-priced vacuum



1278

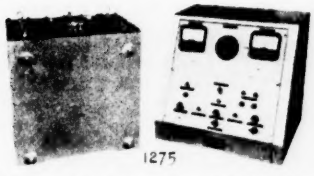
tubes; features fully automatic operation: when equipment is energized, voltage to tubes is run-up gradually; then control circuit automatically actuates at proper time to maintain a stabilized output voltage level pre-set to operate equipment at its peak efficiency.—*The Superior Electric Co., Dept. EM18, Bristol, Conn.*

For more information circle **402** on inquiry card.

power supplies

HV DC POWER SUPPLIES

New air- and oil-insulated Series 2000, offered in 25 basic models with outputs from 0-1 to 0-250 kv at 5 to



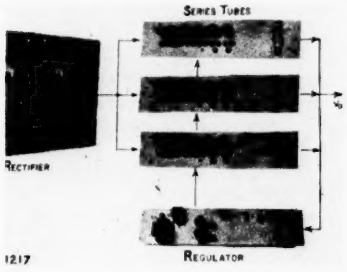
1275

3000 ma, features two-unit construction for remote operation, maximum personnel and equipment protection.—*Sorensen & Co., Beta Electric Div., 333 E. 103 St., New York 29, N. Y.*

For more information circle **403** on inquiry card.

MODULIZED DC SUPPLIES

New high-current regulated dc supplies are sectionalized into three basic panels (see picture). Rectifier voltage ranges (with regulators): 0-150, 150-300, and 300-500; current ratings 1, 3, 6 and 10 amp. Output voltage performance better than



1217

NEW Development!

HICKOK

250° Arc

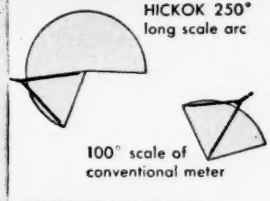
LONG SCALE METERS

Save Valuable Panel Space

The scale in these new instruments is 2½ times as long as conventional meters. A 3½" HICKOK 250° meter has a scale length equal to a conventional 6" instrument.

These exclusive panel style 250° meters fit a smaller space though still provide easier, more accurate readings.

Available in all popular AC or DC ranges. Square, semi-flush or round flush cases. 2½" thru 5½" sizes.



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These instruments meet military specifications and are in volume production. Your inquiry is invited. Kindly list details of your requirements or request Catalog No. 37

THE HICKOK ELECTRICAL INSTRUMENT CO.

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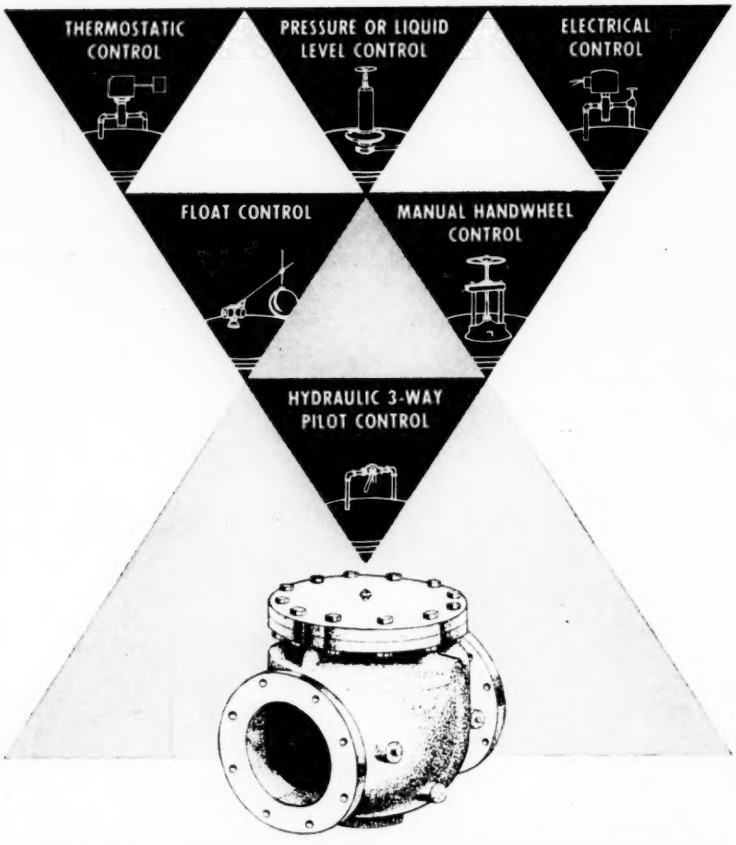
For more information circle **87** on inquiry card.

Select the CONTROL you want for Automatic Valve Operation . . .



with the G-A Cushioned FLOWTROL VALVE

- Operates automatically with air, water, oil or other liquids.
- Fluid in line or independent power source operates valve—surely, dependably!
- Constructed in either angle or globe body with bronze or non-corrosive lining and parts.
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Complete technical data is included in Bulletin W-8A, available on request.

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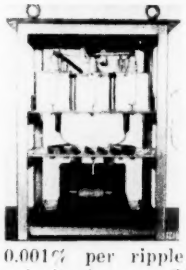
For more information circle **84** on inquiry card.

NEW INSTRUMENTS

0.1% for load and line changes, including transients.—*Dynamic Controls Co.*, 1955 *Massachusetts Ave., Cambridge, Mass.*

For more information circle **404** on inquiry card.

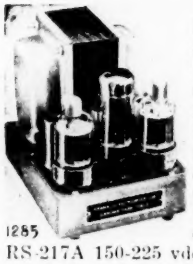
30-kvdc POWER SUPPLY



New low-corona high-voltage power supply, specifically designed with unusual features for electron optical field, features an oil-immersed HV unit with selenium rectifiers and filter to give 0.001% per ripple per ma. Output polarity is reversible by a plug-in.—*Del Electronics Corp.*, 521 *Homestead Ave., Mt. Vernon, N. Y.*

For more information circle **405** on inquiry card.

DC POWER SUPPLIES



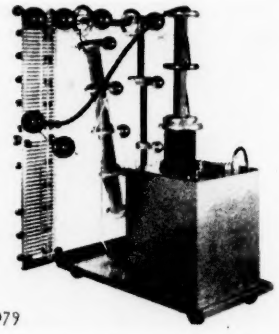
1285

New Models RS-217A and RS-317, for use in lab, test bench or original equipment, feature time-saving demountable construction. RS-317 delivers 225-325 vdc at 175 ma continuous duty; RS-217A 150-225 vdc at 175 ma. Line regulation for both is 0.1%; load regulation 0.1%.—*Trans Electronics, Inc.*, 7349 *Canoga Ave., Canoga Park, Calif.*

For more information circle **406** on inquiry card.

HV POWER SUPPLY

New Beta Model 4250-2 selenium-rectified 0-250-kv power supply, first in this range to be offered commercially, requires input power about 1 kva of 105-125-v 50-60-cps; has manually reversible polarity, 0-250-kv voltmeter and 0-5 microammeter.—*Sorensen & Co., Inc., Beta Electric Div.*, 333 *E. 103 St., New York* 29, *N. Y.*



1979

For more information circle **407** on inquiry card.

electrical and electronic components

SILICON ZENER DIODES

New zener diodes feature exceptionally low temperature coefficient and zener impedance over voltage range. Full calibration data supplied with each diode. Style S series (pigtail type) is rated at 1 watt over a voltage range from 3.9 to 30 in 10% voltage steps. Style T (stud mounted) 3.5 watts, 3.9 to 30 volts in 10% steps. —*International Rectifier Corp.*, 1521 *E. Grand Ave., El Segundo, Calif.*

For more information circle **408** on inquiry card.

PULSE TRANSFORMER KITS

Three new pulse transformer sample kits aid circuit designers. Each kit contains six different pulse transformers, all of which have a 7-pin base, to fit standard 7-pin miniature sockets.—*ESC Corp.*, 534 *Bergen Blvd., Palisades Park, N. J.*

For more information circle **409** on inquiry card.

SILICON DIODE

New 1N658 versatile subminiature silicon junction diode, for computer, communications, military and moderate power applications, is said to combine "characteristics not heretofore available in a single unit": high conductance, fast recovery, high peak inverse voltage, low reverse leakage and a broad operating temperature range.—*Radio Receptor Co., Inc., Germanium & Silicon Div.*, 240 *Wythe Ave., Brooklyn* 11, *N. Y.*

For more information circle **410** on inquiry card.

SILICON POWER RECTIFIERS

New general-purpose 250-v silicon power rectifiers, for industrial 250-vdc service, are available in ac input ratings under 600 v, 3-phase, 60 cps; dc outputs of 75 through 600 kw for two-wire 250-v systems (for 3-wire 125/250-v systems, 75 through 150 kw).—*General Electric Co., Schenectady* 5, *N. Y.*

For more information circle **411** on inquiry card.

COMPOSITION RESISTORS

New Coldite 70+ Series fixed-composition resistors are high-performance units for higher operating temperatures and critical environments. Their characteristics far exceed stringent MIL-R-11B (Amdt 1) requirements, especially in load-life and moisture resistance. Available in MIL-R-11B Styles RC-20 (½-watt), RC-32 (short 1-watt), and RC-42 (2 watts). Resistance tolerances of 5%, 10%, and 20% in all EIA preferred resistance values.—*Stackpole Carbon Co., Electronic Components Div., St. Marys, Pa.*

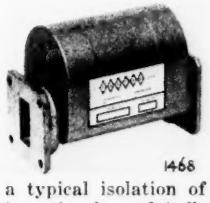
For more information circle **412** on inquiry card.

BLOCKING OSCILLATORS

New transistorized blocking oscillators having minimum pulse widths of 0.2 usec, with rise and fall times down to 0.04 usec, work with up to 30 v power input (designs easily altered for varying input voltages). Pulse repetition rates up to 800 kc; amplitudes about 40% of applied voltages.—*Epsco Components*, 108 *Cummington St., Boston* 15, *Mass.*

For more information circle **413** on inquiry card.

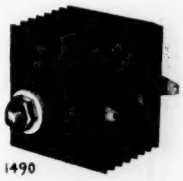
LOAD ISOLATOR



New ferrite BX-812-I utilizes resonance-absorption principle; covers entire useful X-band from 8.2 to 2.4 kMc; has a typical isolation of 20 db with an insertion loss of 1 db.—*Rantec Corp., P. O. Box* 18, *Calabasas, Calif.*

For more information circle **414** on inquiry card.

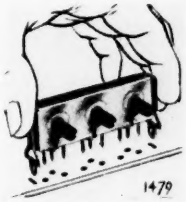
SELENIUM RECTIFIER



New High Current Rectifier features size and cost reduced up to 50% without sacrificing voltage rating; is available in six cell ratings from 18 to 36 v.—*Vickers Inc., Electric Products Div.*, 1815 *Locust St., St. Louis* 3, *Mo.*

For more information circle **415** on inquiry card.

2-IN-1 AND 3-IN-1 PLUG-INS



New 2- and 3-unit Side-by-Side variable resistors with plug-in mounting brackets are available in twelve basic types, each with 17 shaft lengths; eliminate many production operations needed to mount separate conventional controls. —*Electronic Components Div., Stackpole Carbon Co., St. Marys, Pa.*

For more information circle **416** on inquiry card.

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switches and relays

TINY PUSH BUTTON SWITCH

New Series 39-1 sp-st momentary-contact n-o unit is conservatively rated 0.1 amp at 115 vac resistive.

In tests it was operated at 1 amp 115 vac resistive for over 200,000 operations with no appreciable increase in contact resistance and no deterioration of insulation resistance.—*Grayhill, Inc., 561 Hillgrove Ave., La Grange, Ill.*

For more information circle **417** on inquiry card.

HEAVY-DUTY RELAY

New Series 300 for rugged industrial applications, primarily a resistance-operated device, controls up to 5-amp loads on signals of milliwatt range. Special features include automatic or manual reset controlled by internal slide switch, and fast recycling rate.—*Datascan, Inc., 48 Notch Rd., Little Falls, N. J.*

For more information circle **418** on inquiry card.

PAIR OF LIMIT SWITCHES

New pair of hermetically-sealed two-circuit limit switches, featuring compact size and high electrical capacities, comprises: 5LSI roller-plunger-actuated switch especially effective for cam or slide operations, rotatable 90° from switch cover plate; and 2LSI plunger-actuated switch offering full ¼" overtravel. Contact arrangements of both switches are dt-2-circuit, sp-db. (Sp-dt unit can be obtained by tying together one n-o and one n-c terminal and using this as a common terminal).—*Micro Switch, Freeport, Ill.*

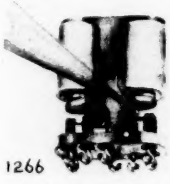
For more information circle **419** on inquiry card.

LATCHING POWER RELAY

New Series 61 dc polarized relay (dp-dt with 4 separate contact circuits) switches loads of 1 to 2 kw in response to momentary ¼ to ½ watt signals. Use of a permanent-magnet latch in place of mechanical latching devices eliminates all moving parts but one, lengthens relay's life and increases its resistance to shock and vibration.—*Sigma Instruments, Inc., 48 Pearl St., South Braintree 85, Mass.*

For more information circle **420** on inquiry card.

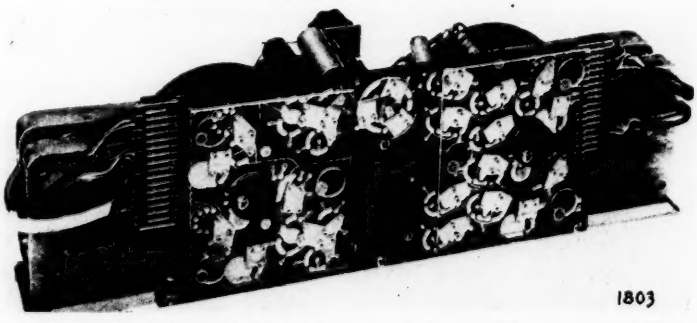
SHOCK-RESISTANT RELAY



New SC micro-miniature relay employs a permanent magnet to obtain exceptionally high shock and vibration resistance: it remains operative under shocks of 100 *G*, vibrations of 30 *G* to 2000 cps and linear accelerations of 400 *G* with no contact openings. It operates on about 1 watt; is a dpdt relay capable of switching 2 amp at 30 vdc or 1 amp at 115 vac resistive.—*Potter & Brumfield, Inc., Princeton, Ind.*

For more information circle **421** on inquiry card.

CIRCUIT BOARD INTEGRAL SWITCH



New HEP (Hartsock Etched Plate) switch "brings the switching operation to the circuit instead of the circuit being brought to the switch"; reduces soldered connections up to 80%; minimizes switch wiring errors; has a much longer life expectancy than do conventional wafer-type switches; enables design of small products with few components.—*Hartsall Div., Allison Labs., 14185 E. Skyline Drive, La Puente, Calif.*

For more information circle **422** on inquiry card.

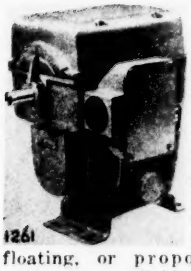
motors, etc.

SMALL SERVOMECHANISMS

New servomechanisms for instrumentation and medium-power applications provide displacement output exactly related to low-voltage dc input. Each consists essentially of (1) transistorized servo amplifier, (2) dc-to-dc converter, (3) servomotor; (4) position feedback and voltage-dividing error-measuring means. Maximum errors do not exceed 1.5% of full-scale rotation and special motors can be had with even better armature-segment resolution.—*Advanced Research Associates, Inc., 4128-B Howard Ave., Kensington, Md.*

For more information circle **423** on inquiry card.

ELECTRIC ACTUATOR



New actuator operates valves, dampers, variable-speed drives, variable transformers, etc., in obedience to signals from electric control instruments. Two models, each having two-position, floating, or proportional control modes, are available in various speeds and torques. All have anti-hunt, overtravel-protection and arc-suppression features.—*Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

For more information circle **424** on inquiry card.

ROTARY ACTUATOR

New SM-11-X Valvetrol mounts directly on stem of rotary valves; provides positioning accuracies of 0.2% of full-scale for standard models or 0.01% in special types; is available in totally-enclosed housings as well as explosion-proof; provides proportional control for valves requiring from 1/6 to 40 turns and stem torques up to 800 lb-in.—*The Jordan Co., Inc., 3235 W. Hampton Ave., Milwaukee 9, Wis.*

For more information circle **425** on inquiry card.

SHORT-STROKE FORCE APPLICATOR

New Dynastroke Linear Force Motor is a moving-coil device less than 2" long, which produces a linear motion

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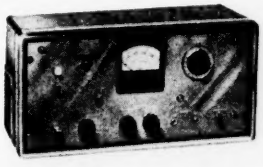
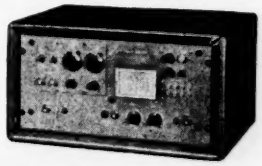


Logarithmic Count Rate Meter

Model 727 Logarithmic Count Rate Meter (ORNL Spec. Q1454B). A wide range, five decade instrument for use with all types of radiation detectors. Range 10-1,000,000 counts per minute.



Linear Amplifier

Model 751 Linear Amplifier (ORNL Spec. DD2) for scintillation spectrometry, reactor control, etc., and other applications requiring high gain and resolution, good linearity, and fast overload recovery.

Single Channel Analyzer

Model 695 Single Channel Differential Analyzer (ORNL Spec. Q1192). A differential pulse height analyzer for separating pulses of varying amplitudes.

Hi-Speed Scaler

Model 762 Hi-Speed Scaler (ORNL Spec. Q1743). For counting pulses from nuclear instruments at high rates with low coincidence loss. Decade counting circuits, instead of binary feedback, improves reliability substantially.

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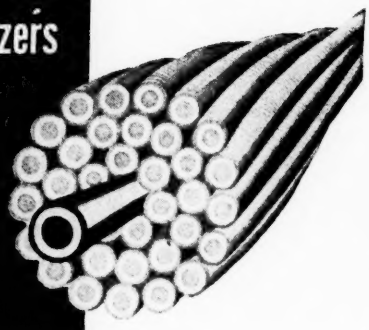
For more information circle **86** on inquiry card.

DIT-MCO Circuit Analyzers *SIMULTANEOUSLY* Test One Wire Against All Others Without Special Connections!



DIT-MCO's Exclusive "One Wire" Test Detects Combined Leakage Resistance Values in Complex Multiple Circuits!

● Minute flaws or finite leakage in electrical systems *can* cause disaster! Unlike many other circuit testers, DIT-MCO *detects* these potentially dangerous flaws and borderline insulation fault conditions including: oxidation, contamination, heat, moisture, carbonization, electrolytic action, and chemical action. Even slight insulation damage caused by pinching, chafing, bending and tight lacing can be detected. Utilizing the thoroughly accurate and dependable "One Wire" test, the Model 200 detects *combined* leakage resistance values by testing one wire against all other wires *commoned together* . . . without special connections. Leakage resistance is detected from zero to 500 megohms and the value can be adjusted to pre-determined specifications.

● The Analyzer's continuity test rejects 1/10 ohms continuity resistance as an open circuit, at currents up to 2 amperes. Borderline continuity resistance flaws such as: incorrect or loose connections, cold solder connections and faulty switches, relays, etc, are also detected to finite values. An electronic detector unit establishes test parameters to meet the most exacting specifications. This careful testing for small errors means that DIT-MCO approved circuits cannot contain minute flaws which become exaggerated and dangerous in the system operation.

● The exclusive DIT-MCO Matrix Chart pinpoints error location, circuit number, type and amount of error, enabling technicians to correct the fault without reference to diagrams or manuals. The chart also provides a permanent record of each test and requires no interpretation or guesswork by operators.

● DIT-MCO's Model 200 thoroughly tests circuits connected together at common terminal points such as grounding lugs, switches or relays. It automatically *energizes* and *functionally* tests solenoids, relays, actuators, panel lights and all external devices. Straightforward adapter cables adapt the Analyzer to any test, eliminating the need for modification within the machine. The operator can easily recheck corrected faults or spot test any circuit manually, without re-cycling.

● The Model 200 is a universal, highly accurate circuit tester which makes rapid, sequential tests of any complex, multiple interconnected circuitry at any stage of production, modification or maintenance. It automatically tests up to 200 circuits and can be expanded to test as many circuits as desired with the use of multiplier sections. The Analyzer is built with rugged, standard telephone-type components which give years of trouble-free service with minimum maintenance. Non-technical personnel easily master operation with less than one-half hour instruction.

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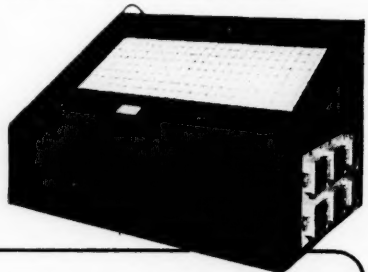

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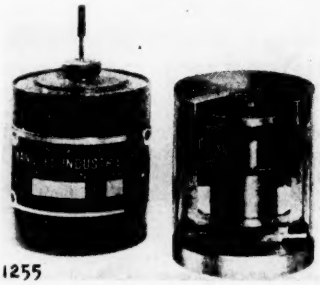
For more information circle **88** on inquiry card.

NEW INSTRUMENTS



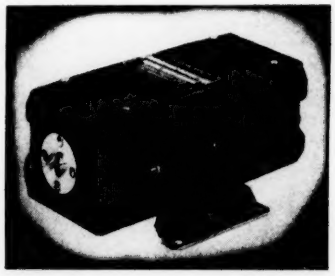
1255

or force accurately proportional to exciting current. It is available with strokes to 0.1"; force outputs to 2 lb; accuracy better than 0.1%. Applications include force balances, high-speed valve actuators, etc.—*Mandrel Industries, Inc., P. O. Box* 13243, *Houston* 19, *Texas.*

For more information circle **426** on inquiry card.

M-G SETS

New features have been added to entire line of Genemotors: 1958 models have been redesigned for better



performance and easier maintenance. —*Carter Motor Co.,* 2711*A W. George St., Chicago, Ill.*

For more information circle **427** on inquiry card.

connectors, etc.

PRINTED CIRCUIT CONNECTORS

New GPCW connectors with dip-solder terminals enable printed circuit boards to be joined at right

1234

angles economically. Their contact efficiency assures maintenance of desired circuit characteristics. Available from stock, molded in high-strength Fiberglas-filled Plaskon alkyd.—*Gorn Electric Co., Inc.,* 845 *Main St., Stamford, Conn.*

For more information circle **428** on inquiry card.

TEFLON COAX CABLES

Two new Teflon dielectric coaxial cables: 421-103 (vinyl jacket) and 421-121 (Fiberglass jacket) are similar except for jackets; are electrically

equivalent to RG-117/U; impedance 50 ohms, dielectric strength 10,000 volts rms and maximum attenuation 3.0 db/100 ft at 400 Mc. Power handling ratings 6 times greater than comparable polyethylene types.—*Amphenol Electronics Corp.*, 1830 *S. 54th Ave., Chicago* 50, *Ill.*

For more information circle **429** on inquiry card.

WATERPROOF CONNECTORS

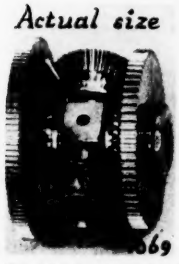
New environmental miniature connectors feature quick-disconnect locking device which locks automatically

when engaged. A resilient grommet, compressed in rear of plug and receptacle after soldering, completely captures and isolates each individual solder pot. All contacts, to one another and to ground, are completely isolated by resilient gasket and grommet.—*Viking Industries, Inc.*, 21343 *Roscoe Blvd., Canoga Park* 1, *Calif.*

For more information circle **430** on inquiry card.

mechanical components

DIFFERENTIALS



New Double Pinion Hollow Shaft Differentials can operate at speeds as high as 2500 rpm with up to 32 oz-in torque inputs; use AGMA Precision Class II gearing and precision shielded ball bearings. Backlash at no-load is under 1 minute. Great flexibility with interchangeable end gears easily field-installed.—*Reeves Instrument Corp.*, 207 *E. 91st St., New York* 28, *N. Y.*

For more information circle **431** on inquiry card.

MINIATURE COUPLINGS

New Type T miniature stainless steel precision couplings, with Nylon or oil-less center block, are available in pin type and clamp type hubs in bore sizes from ⅛" to ¼".—*PIC Design Corp.*, 477 *Atlantic Ave., East Rockaway, N. Y.*

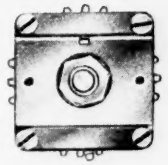
For more information circle **432** on inquiry card.

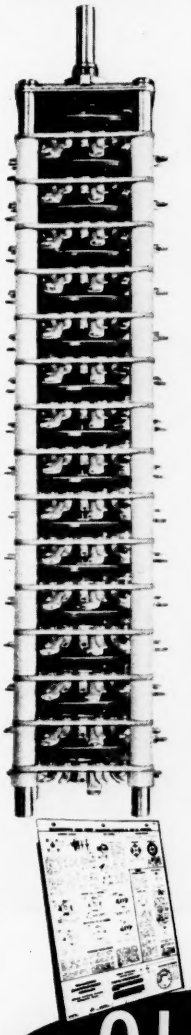
LOCKING CLIPS

New sizes added to line of locking clips securely hold ferrule resistors and other cylindrical components un-

NEW Compactness . . . *NEW* Versatility in

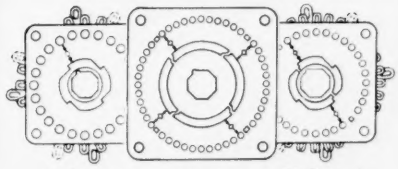
ROTARY SWITCH DESIGN



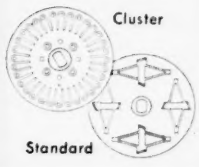


SHALLCROSS *Miniature* ROTARY SELECTOR SWITCHES give the long-lasting dependability of multi-leaf wiper, button-contact design . . . *and* the added advantages of compactness and new versatility. The sketches below detail some of the many unusual features of this new switch series . . .

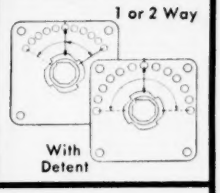
11¼°, 22½°, 15°, 30° INDEXING
1, 2, 3 & 4 POLE



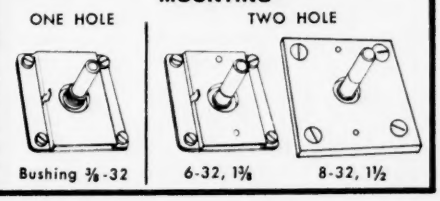
ROTORS



SPRING RETURN



MOUNTING



ELECTRICAL SPECIFICATIONS: Operating Voltage—to 2000 volts; Breakdown Voltage—to 3000 volts; Breaking Current—5 amp @ 125 V. ac.; Carrying Current—15 amp.

Write for complete specifications on the new Shallcross "Miniature Series".

Shallcross

SHALLCROSS MANUFACTURING COMPANY, 510 Pusey Avenue, Collingdale, Pa.

For more information circle **89** on inquiry card.

precision timers by... STANDARD TRADEMARK

Industry's preferred "instrument of a thousand uses". Accurate, rugged, versatile STANDARD Elapsed Time Indicators. Synchronous motor drive. Electric clutch controlled by manual or automatic switch or output of electronic tubes. Manual or electric zero reset. Units for flush panel mounting or portable use.

Model	Scale Divisions	Totalizes	Accuracy
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min.
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.

PANEL MOUNTED

PORTABLE

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For more information circle **90** on inquiry card.

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MIGHTY SERIES "T"

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- ★ .975" x .975" x 1¾" high
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- ★ Sensitivity down to 6 milliwatts
- ★ Coil Resist. up to 20,000 ohms
- ★ Will meet MIL-R-5757C

The latest addition to a line of miniature hermetically sealed sensitive relays, the new Kurman Series "T", weighing only 3½ oz., is now available—the mighty midget of the sensitive class. Radically different in design, you will find the Series "T" to be superior in performance — economically priced with excellent delivery service.

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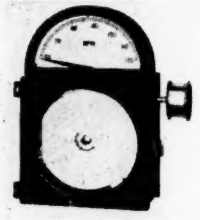
TESTERS

for papers, twine, wire, plastic, aluminum foil, tape, etc. Many models in capacities from 25 to 1500 lbs.

Recording Tachometers



To facilitate the tracing and checking of production, Amthor Recording Tachometers provide a permanent and complete production report each day.

They record Speed and Rate of Production—Changes in Speed—Starting and Stopping Times—All Slowdowns and Non-Productive Periods, in r.p.m., or f.p.m., gallons p.m., cans p.m., paper per hour, etc. . .

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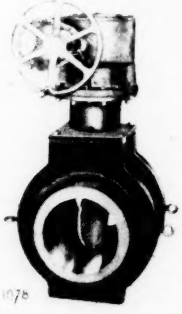
For more information circle **92** on inquiry card.

NEW INSTRUMENTS

der extreme environmental conditions of shock vibration and heat; are now available for diameters from ¼" to $\frac{1}{16}$".—*Atlas E-E Corp., 47 Prospect St., Woburn, Mass.*

For more information circle **433** on inquiry card.

valves



BUTTERFLY VALVE

New No. 889 14" alloy steel R-S butterfly valve, particularly suitable for process industries, is designed for unusually high pressure services: 2630 psi at 450° F.—*S. Morgan Smith Co., York, Penna.*

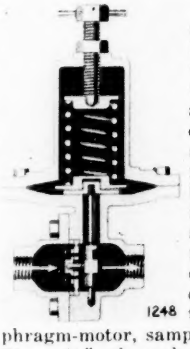
For more information circle **434** on inquiry card.

BY-PASS VALVE

New high-capacity all-bronze automatic by-pass valve is set to open at required pressure; when system demand is reduced, excess liquid is bypassed back to supply. Models are available with fixed setting for relief-to-atmosphere applications. Available in ¾" and 1" sizes, 10 to 250 psi.—*Watts Regulator Co., Lawrence, Mass.*

For more information circle **435** on inquiry card.

REGULATOR VALVES



New models of sliding-gate regulator and control valves are now available in Monel and aluminum for corrosive fluid services. (Also furnished in bronze and cast iron.) Photo shows pressure reducing valve; other types include temperature control, diaphragm-motor, sampling, and mixing. Sizes ¼" through 6".—*Jordan Industrial Sales Div., OPW Corp., 6013 Wiehe Rd., Cincinnati 13, O.*

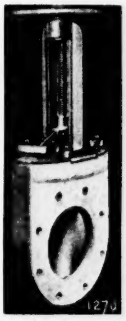
For more information circle **436** on inquiry card.

METERING VALVES

New PY270 Series are made of type 316 stainless steel, have slow-rising stem requiring 20 complete turns to open or close; ⅛" or ¼" female NPT. —*Hoke, Inc.*, 136 S. *Dean St., Englewood, N. J.*

For more information circle **437** on inquiry card.

STOCK VALVE



New plastic-body valve, especially suitable for paper stock, is more corrosive-resistant than stainless steel. Its plastic body is glass-reinforced with high-impact polyester resin; is also more economical than steel. —*W. G. Racaig and Associates, Inc.*, 1945 *N. Columbia Blvd., Portland* 17, *Oregon.*

For more information circle **438** on inquiry card.

PURGE SEQUENCE VALVE

New Fig. 1000 triple interlocked valve provides a hazard-free means of steam purging or scouring oil burner tips. Its cycle positively prevents admission of oil to a hot firebox before admission of atomizing steam.—*Atlas Valve Co., 280 South St., Newark, N. J.*

For more information circle **439** on inquiry card.

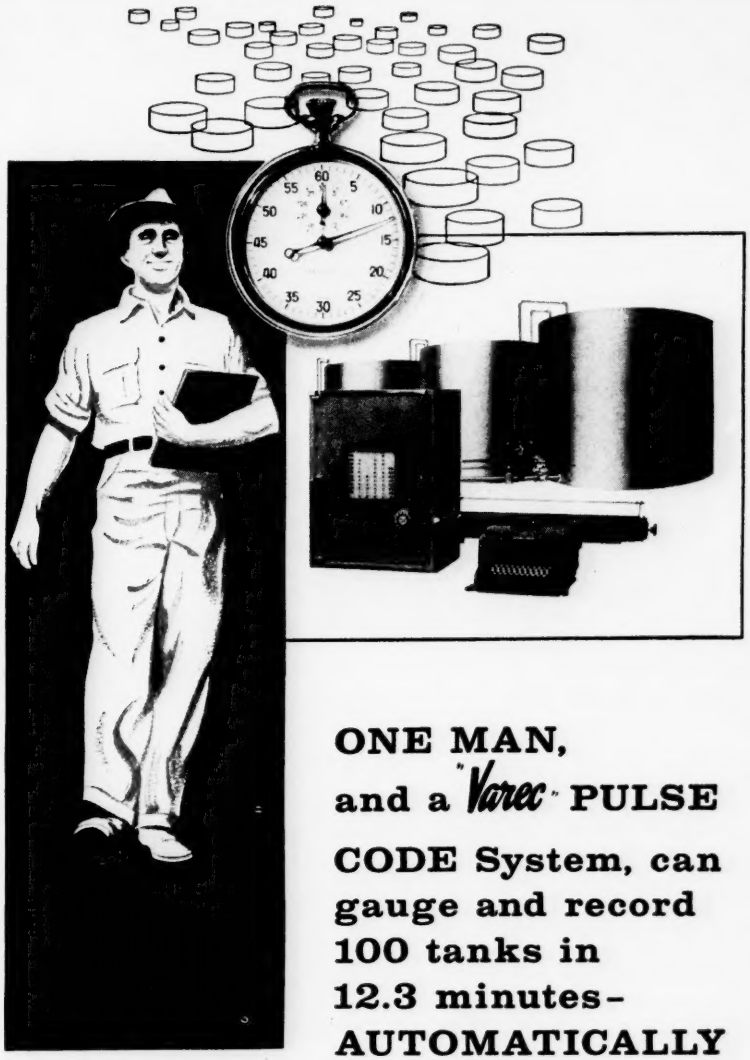
HIGH-VACUUM VALVE

New Type SV, said to be the only commercially-available solenoid valve specifically designed for high vacuum service, features complete freedom from leakage and high flow conductance. If maintenance is required after rated 75,000 cycles, valve can be easily removed from lines.—*Veeco Vacuum Corp., 86 Denton Ave., New Hyde Park, N. Y.*

For more information circle **440** on inquiry card.

SAFETY GAS VALVE

New Model 760 provides positive protection for emulsion treaters from pilot failure; can be opened only after its mercury-actuated element has be-



ONE MAN, and a "Varec" PULSE CODE System, can gauge and record 100 tanks in 12.3 minutes—AUTOMATICALLY

Quite a job for one man—and quite a saving for his employer. A saving in labor, time and overflow losses, and an increase in production efficiency. The secret, of course, is the "Varec" PULSE CODE equipment wisely specified by the farm operator. He has discovered what thousands of successfully operating "Varec" installations have been proving for years: that automation *means* reduced operating costs, and automation by "Varec" *guarantees* it.

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Investigate the opportunities of a "Varec" installation for your tank batteries. Competitively priced in initial cost, unmatched in record of performance, when you specify "Varec," you are buying the best.

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For more information circle **93** on inquiry card.

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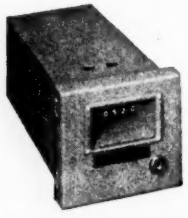
DIRECT READING DIGITAL SERVO INDICATOR

- FAST EVALUATION
- DIGITAL COUNTER TYPE INDICATION
- HIGH RESOLUTION AND ACCURACY



Gilmore Digital Servo Indicator Model 143 supplies a highly readable digital counter type indication of millivolt or resistance changes developed by force, flow, weight, and temperature transducers. Excellent where precise, fast evaluation and high resolution are required. Direct reading eliminates human errors from parallax and interpolation that occur with dial and pointer scales. Accuracy is ±0.1% of span. Indicator case measures 6" x 5⅜" x 14⅜". Write for Bulletin S-5011.

PORTABLE FORCE CALIBRATOR

- DIRECT READING
- AUTOMATIC BALANCE
- PRIMARY CALIBRATING STANDARD

The new Gilmore Portable Force Calibrator, Model 170, is a direct reading, automatic balance, extended range digital servo indicator that, together with a strain gage load cell, gives a fast, simple method of calibrating existing weight, force, and thrust measuring systems. Direct digital readout requires no interpolation of reading and, in most ranges, no application of correction constants. System accuracy is 0.1% of reading or 0.1% of lowest range, whichever is greater. National Bureau of Standards calibration can be supplied. Unit weighs only 40 lbs., requires no batteries or standardization circuit. Write for Bulletin S-5030.

Instrumentation Systems For Industry and Science.

GILMORE INDUSTRIES, INC.

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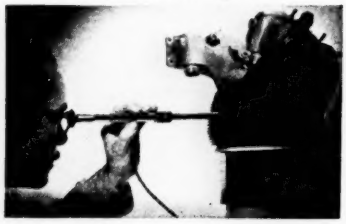
West Coast Office: 5245 King St., Riverside, Calif.

For more information circle **94** on inquiry card.

TESTA BORESCOPE

For Visual Inspection of Inaccessible Surfaces



Provides "inner eye" for inspection of combustion and compression engines, for oil and gas tanks, for hollow castings or bearings, for all internal surfaces which are dark and allow access only through a hole as small as ½". Used by leading aircraft and industrial companies.

Built-in illumination. Contains 12 highly corrected, achromatized, fluoride-coated lenses. Magnification varies with distance—from 2x at 12" to 6.25x at 3".

Two standard models: B20—½" dia. x 20" long and B29—½" dia. x 29" long. Write today for Technical Bulletin #8500.

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MANUFACTURING COMPANY

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For more information circle **95** on inquiry card.

Flow Visualization Instrumentation

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Catalog upon request

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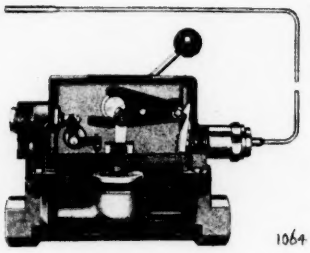
For more information circle **96** on inquiry card.



1064

come red hot from contact with pilot flame.—*The Partlow Corp., 504 Campion Rd., New Hartford, N. Y.*

For more information circle **441** on inquiry card.

NYLON-BODY CHECK VALVE

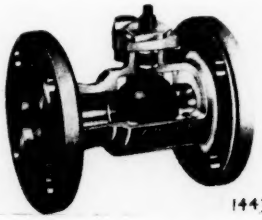
1247

New 1½" No. 15 Insertable Union Check Valve has body of 101 grade nylon; features low pressure drop; installs easily in existing piping.—*Jordan Industrial Sales Div., OPW Corp., 6013 Wiehe Rd., Cincinnati 13, Ohio.*

For more information circle **442** on inquiry card.

SMALL SIZE BALL VALVES

New small-size flanged Double-Seal Ball Valves, in ½" to 2" sizes,

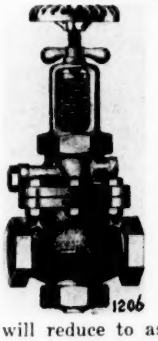


1443

have been added to maker's line.—*Jamesbury Corp., Worcester, Mass.*

For more information circle **443** on inquiry card.

REDUCING VALVES



1206

New models of Type B Pressure Reducing Valves feature stellited main valve at no increase in price (in addition to stellited pilot valve and stellited pilot valve seat). Type B is a spring-loaded piston-operated valve actuated by an internal pilot; inlet up to 1500 psi at 900° will reduce to as low as 0.5 psig in one stage.—*Atlas Valve Co., 280 South St., Newark 5, N. J.*

For more information circle **444** on inquiry card.

HIGH-FLOW SOLENOID VALVES

New compact inexpensive pilot-operated 2-way solenoid valves permit full flow of air, water, oil and other common media. Illustrated model is less than 4" high but provides a full $\frac{1}{2}$" orifice with either $\frac{3}{8}$" or $\frac{1}{2}$" pipe taps. Service life millions of cycles through pressures from 5 to 150 psig and temperatures from −40°F to 180 F. New valves can operate in any position.—*Skinner Electric Valve Div., 105 Edgewood Ave., New Britian, Conn.*

For more information circle **445** on inquiry card.

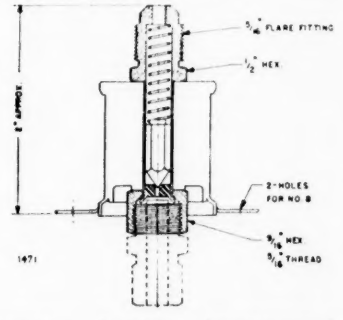
ALL-PLASTIC GATE VALVE

New Flex-Plug, said to combine best features of gate and globe valves, controls corrosive and abrasive liquids that cannot be chemically contaminated. Features: a conically shaped plug, and a resilient easily-removable synthetic cap on inside of body. No obstruction to fluid flow when fully open. When partly open, design minimizes turbulence. Immediately available in 1" and 2" sizes with screwed ends ($\frac{1}{2}$" to 4" sizes shortly).—*Vanton Pump & Equipment Corp., 201 Sweetland Ave., Hillside, N. J.*

For more information circle **446** on inquiry card.

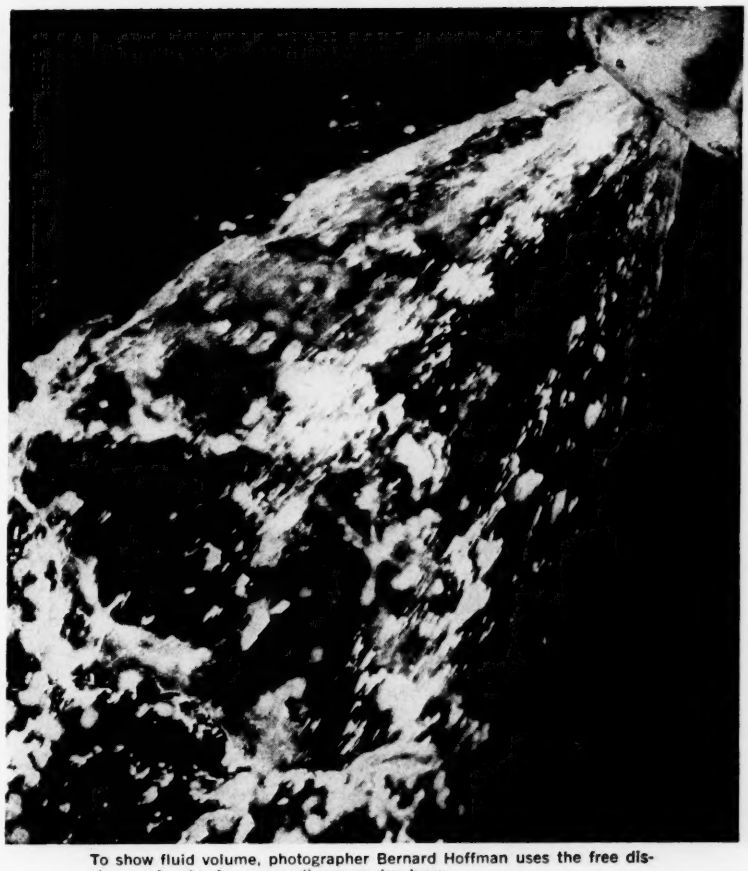
SOLENOID VALVE

New low-cost miniature valve differs from conventional models in that flow is straight through solenoid



armature housing—advantageous in meeting space requirements of commercial equipment. Suitable for use with edibles and corrosive materials (available with Monel and stainless steel parts).—*Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Box 400, Knoxville 1, Tenn.*

For more information circle **447** on inquiry card.



To show fluid volume, photographer Bernard Hoffman uses the free discharge of water from an ordinary garden hose.

Controlling Volume in Fluid Engineering

Few volume control problems can be solved with a quick twist of your wrist the way you do with a garden hose nozzle. In processing equipment, the factors of pressure, flow, and time must also be carefully considered. That's why, when you need accurate answers, you can depend on the broad engineering background S. Morgan Smith offers.

Take an SMS Rotovalve, for instance. Its full line opening means least head loss, lower pumping costs. Hydraulic imbalance and mechanical design make the Rotovalve easy to operate. Fast initial shut-off limits reversal of flow, and closing can be in one second or as slow as required. Final closure is positive and drop tight throughout valve life. SMS Ball Valves, similar to Rotovalves, offer many of these same advantages.

Information on the complete SMS line – R-S Butterfly Valves, Rotovalves and Ball Valves may be obtained by calling our nearest representative. Or, write S. Morgan Smith Co., York, Pa., for data on standard valves or special, engineered applications.

S. MORGAN SMITH HYDRODYNAMICS

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Forces Material Through Tubing

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For more information circle **99** on inquiry card.

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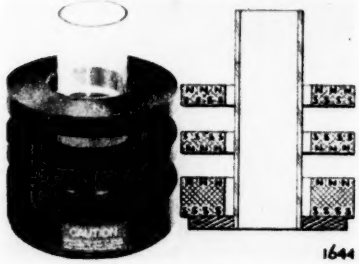
SHORE INSTRUMENT & MFG. CO., INC.
90-35 VAN WYCK EXP.
JAMAICA 35, N. Y.

For more information circle **100** on inquiry card.

miscellaneous

MAG-FIELD DEMONSTRATOR

New Magnetor dramatizes reality of fields; comprises 3 powerful, yet light, ring magnets mounted around



1644

a plastic post. It comes with 2 exploring compasses, a 16-page treatise, and a 6-page brochure describing 10 experiments.—*The Far-A-Field Co., P. O. Box* 271, *Woodstock, N. Y.*

For more information circle **448** on inquiry card.

LEAK DETECTOR

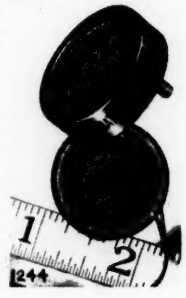
1012

New Infrared-Type Leak Detector detects nitrous oxide gas, comprises: (*left*) Model 15-A Infrared Gas Analyzer plus sampling system with pump and standardizing gas cylinder; (*right*) suction-type probe at end of 30-ft tubing. NO concentrations down to 20 ppm full-scale are detected within 4 seconds.—*Beckman Instruments, Inc., Process Instruments Div.,* 2500 *Fullerton Rd., Fullerton, Calif.*

For more information circle **449** on inquiry card.

SOLAR BATTERY CELLS

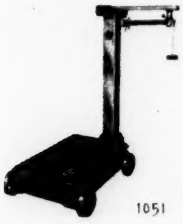
New silicon cells for efficient conversion of radiant energy into electrical power of useful proportions are *p-n* junction units which, when grouped in a series parallel configuration, become primary power source for many devices—especially valuable in remote areas. Available in mounted and unmounted types.—*International Rectifier Corp.,* 1521 *E. Grand Ave., El Segundo, Calif.*



1244

For more information circle **450** on inquiry card.

GENERAL-PURPOSE SCALE



1051

New Centennial Model 57 1000-lb beam scale, signalizing maker's 100th anniversary, is available with single beam, single beam with drop lever, double beam, and full-capacity DU-AL beam.—*Howe Scale Co., Rutland, Vt.*

For more information circle **451** on inquiry card.

MINIATURE TV CAMERA

1067

New MC-16-1, said to be world's smallest high-resolution TV camera, uses a standard 1" Vidicon with 600-line resolution (double the resolution of home TV sets); is ruggedized to operate in high noise and vibration areas.—*Photo Research Corp.*, 837 *N. Cahuenga Blvd., Hollywood* 38, *Calif.*

For more information circle **452** on inquiry card.

BATTERY CHARGER

1252

New automatic constant-current battery charger for silver cells consists of magnetic amplifier-silicon diode modules, each of which supplies an adjustable output of 1 to 5 amp dc. Current is constant into a silver cell battery system comprising from 1 to 50 cells. Automatic shutoff is provided by meter-relays.—*Lee Electric and Mfg. Co.*, 2806 *Clearwater St., Las Angeles* 39, *Calif.*

For more information circle **453** on inquiry card.

TIME CODE GENERATOR

New Airborne Time Code Generator for missiles and aircraft employs transistor-driven magnetic cores,

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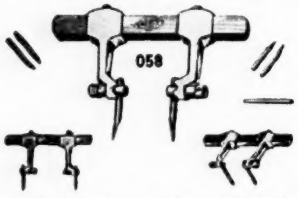

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NEW INSTRUMENTS

supplies a 16-bit 24-hour binary code to hours, minutes and seconds, readable directly to 0.01 sec and by interpolation to 0.001 sec; also continuous pulse trains of 100, 10, 5 and 1 pps. Basic signal source crystal accuracy 1 part in 10^9.—*Electronic Engineering Co. of Calif.*, 1601 *E. Chestnut Ave., Santa Ana, Calif.*

For more information circle **454** on inquiry card.

MICROMINICAM

New Stylophot 124 weighs 2½ oz, uses 16-mm film, features stops from f/3.5 to f/22, focus from 3½ ft to infinity, direct viewfinder, automatic film transport, coated color-corrected lens, sync for both flash bulbs and strobe, double-exposure prevention, daylight loading and unloading; yet its cost with several accessories is under $50.—*Burke and James Inc., 321 S. Wabash Ave., Chicago 4, Ill.*

For more information circle **455** on inquiry card.

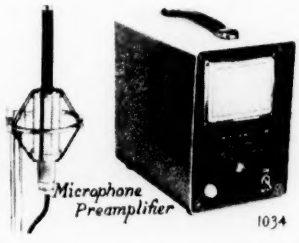
PHOTOCOPIER MODIFICATION

New Verifax 9" Modification Kit permits users of Kodak Verifax Copier, Legal Size, to copy originals up to 9" by 14"; is expected to prove particularly valuable in copying forms that extend right out to margin of paper; includes a 9"-wide Verifax copy paper tray, matrix dispenser, Adapter guide, and squeegee.—*Eastman Kodak Co., Rochester 4, N. Y.*

For more information circle **456** on inquiry card.

PRECISION MICROPHONE

New Model 6100 Laboratory Standard Microphone, for free-field sound pressure measurements between ex-

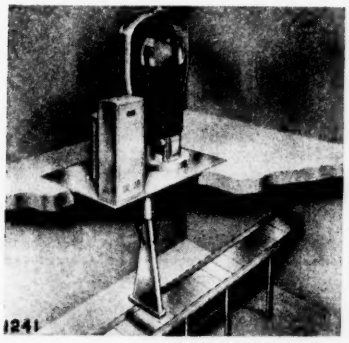


tremely wide limits of frequency, level and ambient pressure, comprises a transducer-cathode-follower probe assembly with removable shock mount, a preamplifier-power supply assembly, and all necessary interconnecting cables. Transducer proper is sealed to tolerate ambient pressures of liquids or gases to 30 psi.—*Electro-Voice Inc., Buchanan, Mich.*

For more information circle **457** on inquiry card.

INDUSTRIAL ACCELERATOR

New Model GS 1½-million-volt Van de Graaff particle accelerator produces ionizing radiation for under



$20,000 per kw and is said to be "the most inexpensive particle accelerator presently available for in-line processing use." Dc in nature, its ionizing radiation can be accurately controlled and monitored.—*High Voltage Engineering Corp., Burlington, Mass.*

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FILTER-SEPARATOR

New SV-11, of replaceable-cartridge type, removes condensed water, waterborne contaminants and solids from fuels, oils, solvents and other oleaginous liquids at flowrates of 5 to 40 gpm with 100% effectiveness; is "the simplest and least expensive such device yet offered."—*Richmond Engineering Co., Inc., 7th & Hospital Sts., Richmond 5, Va.*

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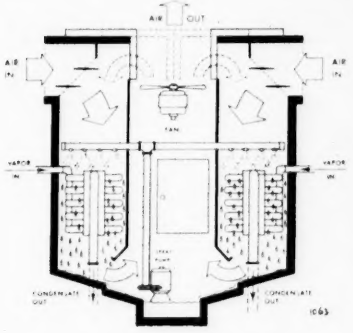
VAPOR CONDENSER

New design of Aero Vapor Condenser uses evaporative cooling with rejection outdoors of heat of condensation; saves power and steam; replaces barometric type condensers



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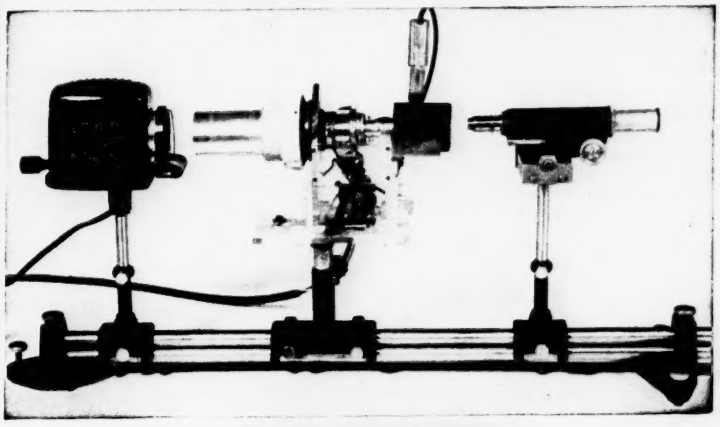

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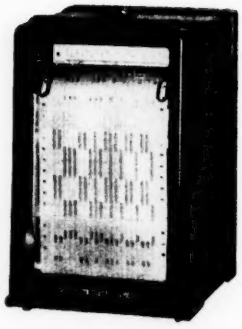

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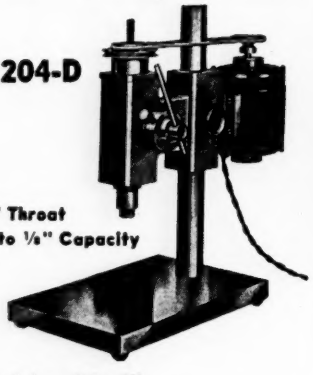

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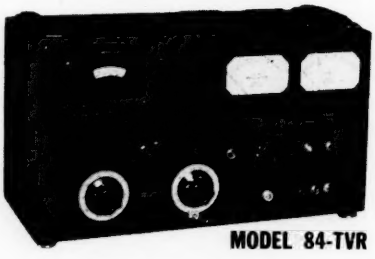

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when needed to conserve water, steam or power or provide a higher vacuum to improve processes.—*Niagara Blower Co., 405 Lexington Ave., New York 17, N. Y.*

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TELESCOPES

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For more information circle **461** on inquiry card.

last-minute items

Combined Expanded-scale Frequency Meter and Frequency-error Detector permits selecting any band within scale of ±5 to ±50 cps with center frequency of 400 cps; indicates deviation of measured frequency from selected band.—Aerojet-General Corp., Azusa, Calif.

For more information circle **462** on inquiry card.

Dc Amplifier. Chopper-stabilized Model 512 features low drift (2 uv) and low noise level (5 uv). Amplifier unit is coupled to 1-channel power unit; single power supply can be used with six channels of amplification in a 19" rack.—Allegany Instrument Co., Inc., Cumberland, Md.

For more information circle **463** on inquiry card.

Excess Hydrocarbons Alarm. New alarm for detection of hydrocarbon in compressed gas for use in high-pressure systems (to 100,000 psi) utilizes a photomultiplier microphotometer.—American Instrument Co., 8030 Georgia Ave., Silver Spring, Md.

For more information circle **464** on inquiry card.

Beta-ray Thickness Gages are for 100% continuous null-method thickness measurement (weight per unit area or volume) and control of thin-sheet materials.—American Tradair Corp., 34-01 30 St., Long Island City 6, N. Y.

For more information circle **465** on inquiry card.

Meter-Relay. New Model 137 is cased in clear plastic so that operation of moving element can be observed. Trip point accuracy 3% (1% at extra charge).—Assembly Products, Inc., P. O. Box XX, Palm Springs, Calif.

For more information circle **466** on inquiry card.

Video Termination. New Type RF-300 for 75-ohm coaxial transmission lines has negligible reactance (less than 2° phase shift) up to 250 Mc; RF resistance at 100 Mc is within 1% of value.—The Daven Co., Livingston, N. J.
For more information circle **467** on inquiry card.

Shipping Shock Recorder. New Model SR-1, only 1¼ x 1¼ x 2¼", is self-contained, inexpensive, easily attached inside shipping case; range 5 G to 150 G.—Dynamic Measurements Corp., 40 So. Los Robles Ave., Pasadena, Calif.
For more information circle **468** on inquiry card.

Sound-synchronizing Kits adapt Kodak Pageant magnetic-optical sound projector for simplified "do-it-yourself" lip-sync sound.—Eastman Kodak Co., Rochester 4, N. Y.
For more information circle **469** on inquiry card.

Compact High-Flow Valve. New Series AG utilizes maker's coaxial principle, provides full-ported flow-rate said to have previously been possible only with valves of twice its dimensions.—Eckel Valve Co., 1425 First St., San Fernando, Calif.
For more information circle **470** on inquiry card.

High Voltage and Deflection Yoke Capacitors, added to maker's line of ceramic disc capacitors, feature high reliability, small size and low cost, meet requirements of TV and instrument manufacturers.—Electra Mfg., 4051 Broadway, Kansas City, Mo.
For more information circle **471** on inquiry card.

6-v and 12-v Battery Eliminator and Charger for servicing transistorized equipment is available in both kit and wired form; incorporates a special heavy-duty choke and filter capacitor circuit.—Electronic Instrument Co., Inc., 33-00 Northern Blvd., Long Island City 1, N. Y.
For more information circle **472** on inquiry card.

Counter Height Instrument Cabinets are engineered to improve operator efficiency and reduce fatigue.—Elgin Metalformers Corp., 630 Congdon Ave., Elgin, Ill.
For more information circle **473** on inquiry card.

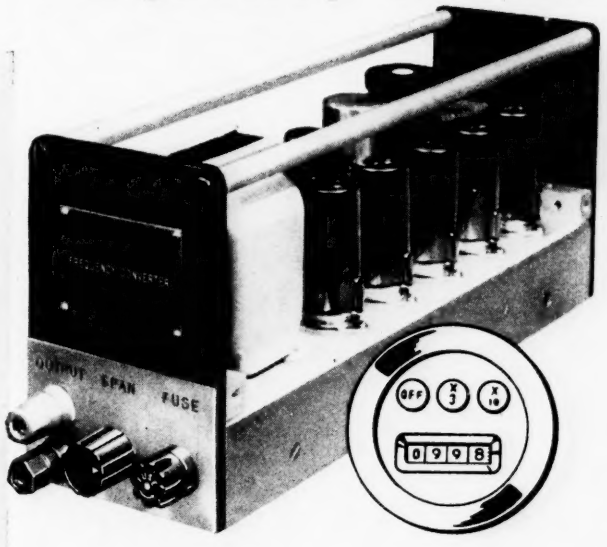
Blade Edge Microscope checks turbine and compressor blades; can be used by unskilled operators: image seen is a normal cross section of blade which can be compared with master drawing.—Engis Equipment Co., 431 So. Dearborn St., Chicago 5, Ill.
For more information circle **474** on inquiry card.

Precision Theodolite. New Mark II, featuring one-second precision, has been redesigned for engineering applications: alignment and setting up of missile launching platforms, rolling mills, etc.—Engis Equipment Co., 431 So. Dearborn St., Chicago 5, Ill.
For more information circle **475** on inquiry card.

Temperature Controller. New explosion-proof feature on Series 541 temperature indicating controller enables its use in hazardous locations.—Fenwal Inc., Ashland, Mass.
For more information circle **476** on inquiry card.

Glossmeters and 45° Reflectometer. New 1958 models meet latest require-

new cox frequency converter



The new Cox Frequency-to-Analog Converter joins the ever growing list of precision instruments designed and built for electronic data handling by the Cox Instruments Division — pioneers in precision flow measuring equipment.

The Type 2 Converter was originally developed for use with the Cox Turbine Flow Measuring System, but is now being widely used in many other applications for extremely linear conversions in telemetering, computers and other transducer-recorder systems. Its high sensitivity, excellent stability and fast transient response, combined with low cost, make it an outstanding converter for all around use.

A new technical bulletin describing the Type 2 Frequency Converter is available upon request. Write to *Cox Instruments Division, George L. Nankervis Company, 15200 Fullerton Avenue, Detroit 27, Michigan.*

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Range	100 to 5000 cps (other ranges available)
Linearity	.1 per cent over 10:1 range
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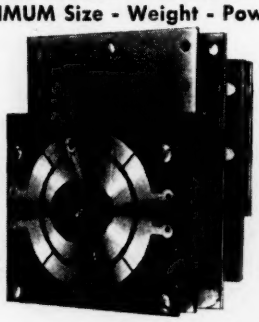

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ments for gloss and reflectance measurements.—Gardner Laboratory Inc., P. O. Box 5728 Bethesda 14, Md.
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Vacuum Cleaner. New air-operated Little Windy Air Vac is ideal for plant and lab; is made of non-ferrous metals: no sparks.—Gardner Laboratory, Inc., P. O. Box 5728, Bethesda, Md.
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Potential Transformers. Industry's first butyl-molded potential transformers, for circuits up to 5-kv, are available in both indoor and outdoor types.—General Electric, Schenectady 5, N. Y.
For more information circle **479** on inquiry card.

Enlarger. New Primos Testreflex $2\frac{1}{4}$x$2\frac{1}{4}$ features a single-lens reflex system with built-in Test-Negative which allows in-stand and parallax-free focusing.—Karl Heitz, Inc., 480 Lexington Ave., New York 17, N. Y.
For more information circle **480** on inquiry card.

Universal Lens. New Alpa-Makro-Kilar 40-mm f/2.8 with preset diaphragm is now available with Swiss Alpa 35-mm single-lens reflex camera.—Karl Heitz, Inc., 480 Lexington Ave., New York 17, N. Y.
For more information circle **481** on inquiry card.

Soldering Tip. New Xtradur has twice the life of ordinary iron-clad tips; 40 stock sizes and many special sizes for all makes of industrial irons.—Hexacon Electric Co., 179 West Clay Ave., Roselle Park, N. J.
For more information circle **482** on inquiry card.

Rate Switch With External Adjustment. New Model No. RS03-0101-1 makes it possible to save time and money on experimental control programs. Rate-of-turn range from 10° to 200° per second.—Humphrey, Inc., 2805 Canon St., San Diego, Calif.
For more information circle **483** on inquiry card.

Plastic Transparent Filters are in-line cartridge-type, featuring aluminum and plastic construction, corrosion-resistant; high flow rates at pressures up to 100 psi.—Ion Exchange Products, Inc., 9349 So. Cottage Grove Ave., Chicago 19, Ill.
For more information circle **484** on inquiry card.

Low-Voltage Lighting Sets provide 200 to 400 watts of grounded illumination in a choice of 6, 12 or 32 v from conventional 120-vac sources; safe to use around metal structures, even in dripping wet conditions.—Dept. V-92, Joy Mfg. Co., 1201 Macklind Ave., St. Louis 10, Mo.
For more information circle **485** on inquiry card.

Generators. Maker's new 60-cps alternators feature new sleeve type exciter, improved panel and mounting feet design, reduced over-all length, improved coupling and adaptor for direct connecting to industrial engines.—Kato Engineering Co., 1415 First Ave., Mankato, Minn.
For more information circle **486** on inquiry card.

Lead-in-air Detector. New kit permits prompt on-the-spot determina-

tion of weight of lead present in a measured volume of air; comes in a lightweight aluminum case with directions and shoulder strap.—Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh, Pa.

For more information circle **487** on inquiry card.

Lab Oven. New floor model No. 5921 forced-convection Univect oven saves lab table space: controls and blower motor mounted under oven chamber.—National Appliance Co., 7634 S. W. Capitol Highway, Portland, Ore.

For more information circle **488** on inquiry card.

Pulse-Height Analyzer and Scaler in Single Chassis. New Model 132 Analyzer Computer, for use with all gamma-sensitive scintillation counters, is the only one of its kind commercially available.—Nuclear-Chicago Corp., 229 W. Erie St., Chicago 10, Ill.

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Air Monitor. New Model AM-33 is first to record both alpha and beta-gamma activity of airborne particulates as they are collected.—Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind.

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Precision Flow Switch. New Model FS-26 for aircraft fuel transfer can be used with any of the current jet aircraft fuels; immediately shows that transfer has been completed.—Potter Aeronautical Corp., Union, N. J.

For more information circle **491** on inquiry card.

Digital Magnetic Tape Handler. New completely transistorized Model 906 combines features not previously found in tape handlers. High and low tape speeds, four speeds forward and reverse up to 150 ips; rewind or search speeds 400 ips; continuous cycling at 0 to 200 cps without flutter.—Potter Instrument Co., Inc., Sunnyside Blvd., Plainview, L. I., N. Y.

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Counter and Timer. New Model 860 Frequency Time Counter combines preset interval generating, timing, and counting functions, is completely transistorized, has in-line readout.—Potter Instrument Co., Inc., Sunnyside Blvd., Plainview, L. I., N. Y.

For more information circle **493** on inquiry card.

Microminiature Magnetic Latching Relay. New SL dual-coil relay operates on a 1-w 3-ms pulse to either coil, develops more than twice the contact pressure of any dp-dt relay of comparable size.—Potter & Brumfield, Inc., Princeton, Ind.

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Dc Rotary Torque Solenoids incorporate a unique double-cam action which permits torque outputs that can duplicate any torque requirements. Combination thrust and radial bearings reduce axial shaft movement to ±0.0005".—Powerdex Co., 2501 E. 68th St., Long Beach, Calif.

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Utilizing a clock-work mechanism for the chart drive, no electrical power is consumed. All electronic portions of the recorder are completely transistorized minimizing battery drain over existing conventional units. The recorder is manufactured in a circular chart model only with a wide range of chart speeds available. AC Wheatstone bridge self-balancing principle has been incorporated into the recorder with a bridge frequency of 1000 cps.

Unique circuitry keeps the current drawn from the batteries to a figure of less than 8.0 ma when the instrument is not rebalancing and approximately 600 ma when rebalancing. Two 6 volt batteries are supplied with the instrument and are sufficient for two months of continuous operation. Numerous battery packs can be supplied in both the dry cell and rechargeable types.

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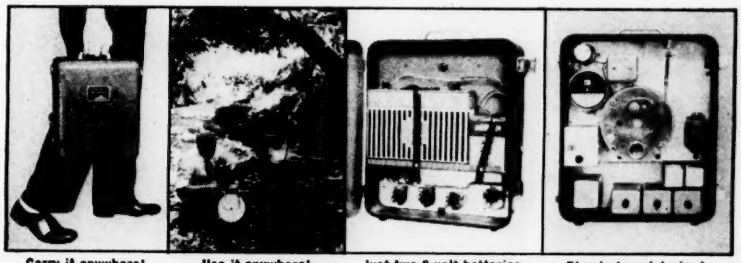

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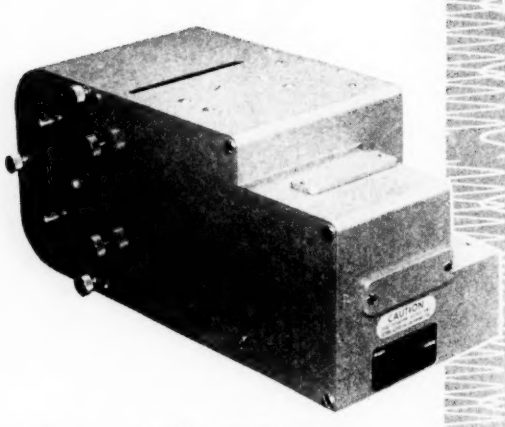

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Century Electronics & Instruments, Inc.
1333 No. Utica, Tulsa, Oklahoma

Representation in Principal Cities

For more information circle **113** on inquiry card.

NEW INSTRUMENTS

markings will not crack, peel, or dissolve; resists any acid or solvent that will not attack thermometer glass.—Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.

For more information circle **496** on inquiry card.

Shielded Coaxial Seamless Tube. New Coaxitube, for electronic controls which must operate under all conditions of weather, altitudes and temperatures, is a unique metal-shielded wire with absolute uniformity of impedance characteristics.—Precision Tube Co., North Wales, Pa.

For more information circle **497** on inquiry card.

Junction Transistors. New 2N407 and its flexible-lead version, 2N408, both of germanium p-n-p alloy type, are intended for class A and class B audio service.—Radio Corp. of America, Semiconductor Div., Somerville, N. J.

For more information circle **493** on inquiry card.

Multi-purpose Silicon Diode. New 1N658, for computer, communications, military and general circuit requirements, combines characteristics not heretofore available in a single unit, features high conductance, fast recovery, high peak inverse voltage, low reverse leakage and a broad operating temperature range.—Radio Receptor Co., Inc., Germanium & Silicon Div., 240 Wythe Ave., Brooklyn 11, N. Y.

For more information circle **499** on inquiry card.

Measuring Angles in Shop. New Opto-Tooling-Auto-Collimator reads directly to one second of arc, 5 microinches; obviates need for sine bars, tables of sines and calculations; tests surface flatness, squareness, parallelism, optical-instrument assembly alignment, etc.—George Scheer Co., Inc., 200 Lafayette St., New York 12, N. Y.

For more information circle **500** on inquiry card.

Ac Voltage Regulator. New tubeless all-purpose Model APR1010, features "flexibility of operation never before available," can be used to regulate average and peak voltages as well as rms, independent of input waveform.—Sorensen & Co., Inc., Richards Ave., So. Norwalk, Conn.

For more information circle **501** on inquiry card.

Hysteresis Motors. New size 20 for 400-cps and HF applications feature high output power; are ideally suited for clutch type servos; are built especially for use in high ambient temperatures.—Syntorque Inc., 601 W. 26th St., New York 1, N. Y.

For more information circle **502** on inquiry card.

Electric Bench-type Furnaces. Four new Type 1800 models have the same chamber dimensions (10x9½x22"), case size and general construction but differ in power requirements (single or 3-phase) and top temperature limits (2000 or 2300°F). Power is consumed only 35% of the time, leaving a substantial reserve for heavy loads, etc.—Thermo Electric Mfg. Co., Dubuque, Iowa.

For more information circle **503** on inquiry card.

Source Calibrator. New improved Model SC-56, for quick determination of activity content of liquid or solid sources of radioactive isotopes, can measure activities from 5 microcuries to 500 millicuries in either of two well-type ionization chambers supplied with unit.—Tracerlab, Inc., 1601 Trapelo Rd., Waltham 54, Mass.

For more information circle **504** on inquiry card.

Drafting Applique Material was developed to overcome problem of appliques which in the past did not adhere to drawing paper after long periods of storage; uses new non-bleeding-type glue and special-type backing paper. As it makes contact with drawing paper it becomes completely transparent. Standard sizes 6x9" and $8\frac{1}{2}$"x11", plain or printed to specs. —Transparent Products Co., Inc., 324 E. 24th St., New York 10, N. Y.

For more information circle **505** on inquiry card.

Temperature Controls. New explosion-proof Type B95 has calibrated setting dial. New explosion-proof Type C95 is an uncalibrated unit set by hexhead adjustment screw. Both types are available with n-o, n-c, or d-t switch, s-p rated 15 amp 115/230 vac; their thermal systems are bellows type.—United Electric Controls Co., 85 School St., Watertown, Mass.

For more information circle **506** on inquiry card.

"Atomic" Lamps. New Isolites provide power-free uninterrupted illumination for periods up to 10 years; comprise phosphor crystals enclosed in a hermetically-sealed transparent capsule and excited to luminescence by radioactive krypton-85 gas; are available in various design configurations and color emissions. —U. S. Radium Corp., Morristown, N. J.

For more information circle **507** on inquiry card.

Transistorized Dosimeter Charger. New Model UAC 750 is a lightweight (1 lb) unit used to zero any standard dosimeter; is powered by one 1.5-v flashlight cell; operates at least 25,000 times.—Universal Transistor Products Corp., 143 E. 49th St., New York 17, N. Y.

For more information circle **508** on inquiry card.

Signal and Sweep Generators. Maker's complete line is now available for mounting on standard size racks.—Van Norman Industries, Inc., Electronic Div., 186 Granite St., Manchester, N. H.

For more information circle **509** on inquiry card.

Transistor Mounting Clips are versatile units designed to clamp transistors or transistor sockets to either insulated boards or metal chassis; are available in models for transistor case sizes now being manufactured.—Vector Electronic Co., 1100 Flower St., Glendale 1, Calif.

For more information circle **510** on inquiry card.

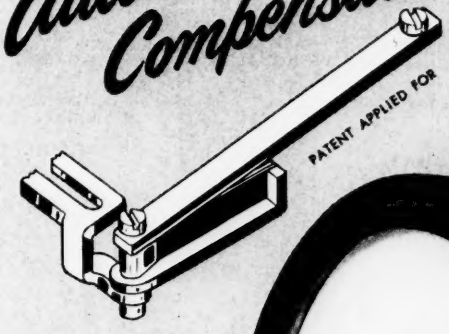
Black Nylon Set Screws are nonmagnetic and have excellent insulating properties; meet service requirements of light weight, toughness, and resistance to corrosion; are precision-molded to ASTS specs.—Weckesser Co., 5701 Northwest Highway, Chicago 30, Ill.

For more information circle **511** on inquiry card.

HEISE GAUGES

NEW

Automatic Thermal Compensator



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Another exclusive feature developed by the makers of the world's most PRECISE PRESSURE GAUGES

NO THERMAL READJUSTMENT OF DIAL ZERO

NO CORRECTION CURVE COMPUTATIONS

DIRECT DEPENDABLE READING AT TEMPERATURES FROM 0° TO 100°F.

Pressure Ranges 15 to 20,000 P.S.I. Dial Sizes $8\frac{1}{2}$"-12"-16"

Prices from $196.75 **DELIVERY WITHIN 30 DAYS**

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HEISE BOURDON TUBE COMPANY, INC.

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For more information circle **114** on inquiry card.

Measure Specific Gravity Accurately!

...and from a remote point

The Petrometer remote reading Specific Gravity Indicator is accurate to .001 Sp. G. unit, with interpolation to .0005 unit! It's easy to install... and operates on the simple, sound principle of a differential bubbler.

An ideal instrument for plant or laboratory for measuring specific gravity of any liquid... paints, fuel, resins, pharmaceuticals, chemical solutions.

All functional parts are conveniently mounted on rear of panel, accessible by swinging open the cabinet door.

Send for Bulletin 7004

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For more information circle **115** on inquiry card.

Check and calibrate any type of thermocouple-actuated temperature instrument with one portable Pyrotest

Read temperatures or millivolts directly ... without graphs, charts or conversion tables

The only portable potentiometer pyrometer with interchangeable direct reading scales

Pyrotest is 9 instruments in one, with 6 standard scales for thermocouples; 3 standard scales for millivolt readings. Special scales for any desired reading or use. Scales interchangeable in 30 seconds. Compact, rugged, easy to carry—12 lbs.; 12" x 9" x 8½". Accurate to 1/6 of 1%. Self-contained power supply. Write for new bulletin 9B.

TECHNIQUE TECHNIQUE ASSOCIATES
P. O. BOX 91
INDIANAPOLIS 6, IND.

For more information circle **116** on inquiry card.

new plants and mergers

A. E. EHRKE & CO.

A. E. EHRKE & CO., Cleveland sales representatives of FISHER GOVERNOR CO., will stock a wide variety of Fisher equipment in the new warehouse shown.

GENERAL TRANSISTOR CORP. has acquired a new plant at Richmond Hills, L. I., N. Y. to start production of germanium and silicon computer diodes.

CLARY CORP. has established a Quality Control Department.

SUPERIOR TUBE announces start of operation of its new million-dollar plant in Wapakoneta, Ohio.

ACOUSTICA ASSOCIATES announces opening of its fourth plant, located in Culver City, Calif.

VAN NORMAN INDUSTRIES announces formation of a new Electronics Division.

CIRCON COMPONENT CORP. has acquired majority of the Griffin Bros. Corp. thus adding more screw machine facilities.

NORDEN-KETAY CORP. — SOLAR AIRCRAFT CO. merger has been approved by the Boards of Directors of both companies.

JUST OFF THE PRESS

CONTROL VALVES

C. S. BEARD

Covers:	Basic Types
Valve Capacity and C_v	Sizing
Flow Characteristics	Positioners
Mechanical Features	Actuators

Completely up-to-date. Covers recent developments such as d-c, electrohydraulic and gas-hydraulic and new positioners. Numerous illustrations and tables.

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INSTRUMENTS PUBLISHING CO.
845 Ridge Ave. Pittsburgh 12, Pa.

AD-YU ELECTRONICS LAB (formerly Advance Electronics Lab) has moved into a newly-constructed building in Passaic, N. J.

BURGESS-MANNING's Industrial Silencer Div. has moved to a new plant in Dallas.

FISCHER & PORTER has moved its Chicago branch into a specially-constructed one-story building in suburban Maywood.

BENDIX AVIATION has established a new control section to engineer, manufacture, and sell tape-controlled production systems.

KEITHLEY INSTRUMENTS announces formation of a new Quality Control Department.

METALS & CONTROLS CORP. has formed a wholly owned subsidiary corporation from its Nuclear Products Div. The new name is M&C Nuclear, Inc.

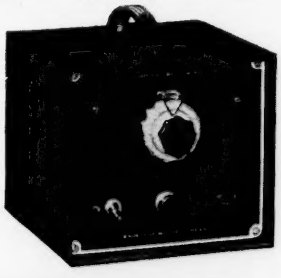
MARCONI INSTRUMENTS has moved from New York to Englewood, N. J.

WEKSLER THERMOMETER CORP. has changed name to **WEKSLER INSTRUMENTS CORP.**

A. W. CASH VALVE MFG. CORP. has acquired a new, extensively remodeled research and engineering facility.

For CLOSE Temperature Control

TEMPERATURE SENSING PROBE



WAUKESHA
TEMPERATURE CONTROLLER

This simple, versatile instrument, developed for ASTM Engine Test Methods for Rating Motor Fuels, is equally well adapted to general laboratory or industrial temperature control applications. Range is approximately 80° F. to 400° F. with the standard sensing pickups. A small thermistor sensing probe and a saturable reactor provide continuously modulated proportional control of the current to the heating element, without moving contacts or relays. It features high sensitivity, close control, and easy adjustment of the control point by coarse and fine co-axial dials. It is housed in the portable cabinet shown, or may be panel mounted. Operates on 110 volts AC to control directly heaters up to 1000 watts, and can be used as a pilot controller for higher load capacity. Write for further information.

Fuel Research Division
WAUKESHA MOTOR COMPANY
WAUKESHA, WISCONSIN

For more information circle **119** on inquiry card.

Single-Point pH Recorder (Strip Chart Assemblies also available)

CAMBRIDGE pH INDICATORS and RECORDERS

Labor saving—profit producing!

In addition to portable pH meters, Cambridge makes line-operated Direct Reading pH Indicators and Recorders for permanent installation. They are accurate, stable and assure continuous and trouble-free performance. Either the Recorder, Indicator or both, may be located at any reasonable distance from one or several sampling points. The Glass Electrodes are placed in vapor-tight housings of clog-free sampling chambers.

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CAMBRIDGE pH EQUIPMENT

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For more information circle **118** on inquiry card.

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For internal visual inspection from a few inches to 85 feet in length
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Special designs readily fabricated from stock parts

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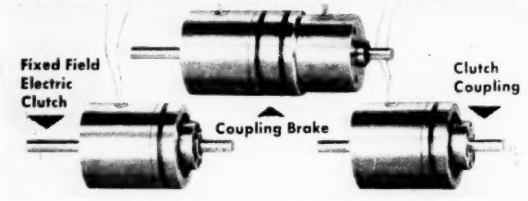
For more information circle **120** on inquiry card.

Introducing . . .

Simplatrol

FIXED FIELD Electric Clutches



In Miniature and Small Sizes

Super compact for use in instruments or assemblies where space is at a premium and performance requirements are high.

Three styles of Simplatrol Fixed Field Clutches ranging from 7/8" to 3 1/8" diameter. Torque output ranges from 10 oz. inches to 100 lb. inches.

Simplatrol Diaphragm Makes The Difference!

The only functional moving part in actuation of Simplatrol Fixed Field Clutches.

When current is applied to magnet, the diaphragm yields as the armature is attracted to the rotor body. Engagement is extremely rapid, smooth and silent.

The Simplatrol principle has been proved by years of use and features a minimum of parts to maintain or replace.

Ask for literature and recommendations on Simplatrol Fixed Field Miniature and Small Electric Clutches and Brakes.

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Representation in Key Industrial Areas

For more information circle **121** on inquiry card.

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Counts faster, yet accurately.
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For more information circle **122** on inquiry card.

people in the news

L. S. PELFREY

T. E. JAMRO

G. F. PLATTS

INTERNATIONAL RECTIFIER CORP. has named *Loucll S. ("Lou") Pelfrey* as director of R & D.

GENERAL ELECTRIC has appointed *Richard P. Gifford* as manager of engineering for the Communication Products Dept.—The Semiconductor Products Department's three manufacturing plants have new managers: For the Buffalo Transistor Plant and the Clyde Semiconductor Rectifier Plant it is *Theodore E. Jamro;* and for the Syracuse Semiconductor Plant it is *George F. Platts.*

BATELLE MEMORIAL INSTITUTE has named *Dr. B. D. Thomas* to the presidency.

WILL CORPORATION has appointed *Roger F. Hogan* as sales manager.

TEXAS INSTRUMENTS' executive vice president *Patrick E. Haggerty* has been elected a Fellow of the IRE.

TRACERLAB announces appointment of *Dr. George Manov* as technical director of its Reactor Monitoring Center. Dr. Manov formerly was technical assistant to AEC Commissioner W. Libby.

For more information circle **123** on inquiry card.

G. M. ARISMAN, JR.

A. C. WENZEL

R. V. HARRIS

P. R. MALLORY & CO. has appointed *George M. Arisman, Jr.* president and general manager.

REPUBLIC FLOW METERS has appointed *Rowland B. Drescher* as assistant sales manager and *Alfred C. Wenzel* as production manager.

PERKIN-ELMER CORP. has appointed *R. Victor Harris* as general manager of the Instrument Div.

APPLIED RESEARCH LABS has appointed *Harry T. Dryer* as applications engineer and supervisor of its Demonstration Center.

HOFFMAN LABS has named *Richard A. Maher* V.P. of engineering.

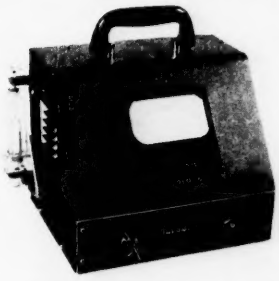
DAYSTROM-WESTON CO. (comprising in a group Weston Instrument Div., Daystrom Systems Div., and Daystrom-Weston Industrial Div.) has named *Thomas Allison* as president and chief operating executive.

GENERAL PRECISION LAB has appointed *Nathaniel M. Marshall* to the new post of associate director for sales of the Industrial Products Div.

DAVIES LABORATORIES Div. of Minneapolis Honeywell Regulator Co. has named *John G. Booth* as general manager.

NEW PORTABLE OXYGEN ANALYZER

MAGNETIC PRINCIPLE



- NO CHEMICALS
- SIMPLE
- RUGGED FOR FIELD WORK
- CONTINUOUS READINGS
- SELF-CONTAINED SAMPLE PUMP, FILTER AND FLOW INDICATOR

This lightweight (35 lbs.) rugged, portable instrument requires only 115 volt, 60 cycle current to provide a continuous indication (0 to 21.0%) of oxygen percentage in otherwise inert atmospheres. It is ideal for checking combustion efficiency, particularly in furnaces where more than one fuel is being used.

Full line of equipment is available in the air rectifying field and process analyzers.

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Highway U.S. #20
LA PORTE INDIANA

For more information circle **124** on inquiry card.

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MANAGER
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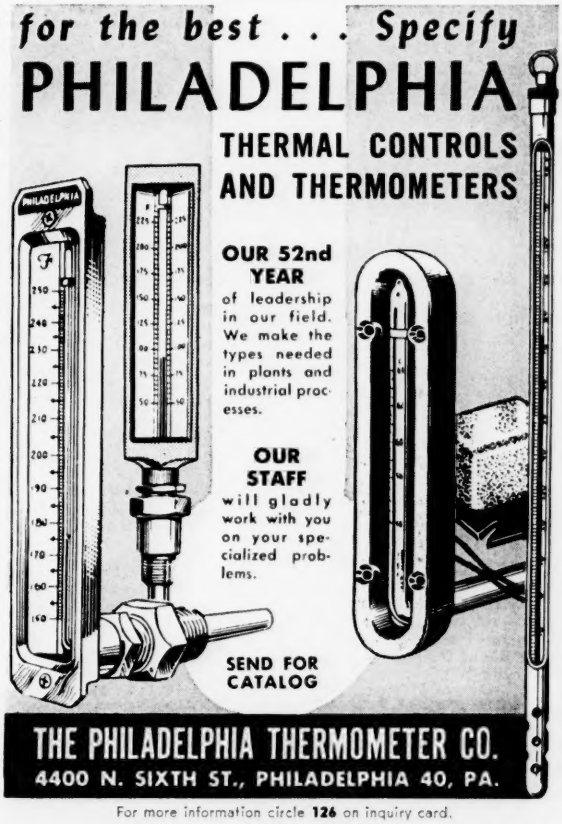
13-19 UNIVERSITY PLACE, NEW YORK 3, N.Y.

For more information circle **125** on inquiry card.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of leadership in our field. We make the types needed in plants and industrial processes.
OUR STAFF
will gladly work with you on your specialized problems.
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4400 N. SIXTH ST., PHILADELPHIA 40, PA.

For more information circle **126** on inquiry card.

new literature

VALVES

CONTROL VALVES. 12-page Bulletin LB-2 covers new Series LB single-seated split-body valves actuated by Cylinder Conomotor which develops 10 to 20 times more power than conventional diaphragm motors.—Conoflow Corporation, 2100 Arch St., Phila. 3, Pa.

Circle **601** on inquiry card.

REGULATORS. 6-page Bulletin J-180 describes new sliding-gate temperature control valves (TCV) with redesigned, strengthened thermal system featured.—6-page Bulletin J-160 covers sliding-gate pressure reducing valves, designed to give dead-end shut-off on all fluid services.—Jordan Industrial Sales Div., OPW Corp., 6013 Wiehe Rd., Cincinnati 13, Ohio.

Circle **602** on inquiry card.

RELIEF VALVES. 2-page catalog insert covers temperature and/or pressure relief valves for water heaters.—A. W. Cash Valve Mfg. Corp., 66 E. Wabash, Decatur 60, Ill.

Circle **603** on inquiry card.

SOLENOID VALVE. 2-page catalog insert Section A, Form E-232 describes new Model 291 general-purpose 2-way ⅛" or ¼" size normally-closed valve which operates in any position.—Controls Co. of America, 2450 North 32nd St., Milwaukee 45, Wis.

Circle **604** on inquiry card.

MANUAL AND SOLENOID VALVES good for up to 10,000 psig pressure are illustrated, described and tabulated in 56-page Catalog 58-59.—Barksdale Valves 5125 Alcoa Ave., Los Angeles 58, Calif.

Circle **605** on inquiry card.

CONSTANT-FLOW VALVE. 8-page pocket-size bulletin explains design, construction and performance characteristics of new diaphragm type with desired flow rate set by handwheel.—Kobe, Inc., 3040 E. Slauson Ave., Huntington Park, Calif.

Circle **606** on inquiry card.

TEMPERATURE REGULATORS. 6-page bulletin describes two new series of steam regulating valves with pilots for both fast and slow heating exchangers.—Spence Engineering Co., Inc., 53 Grant St., Walden, N. Y.

Circle **607** on inquiry card.

PINCH-TYPE VALVES. 16-page catalog fully describes eight standard types and mentions special types of valves with rubber or synthetic inserts. Action is like pinching a garden hose.—RKL Valve & Mfg. Co., Route 38 and Rudderow Ave., Maple Shade, N. J.

Circle **608** on inquiry card.

INSERTABLE CHECK VALVE. 2-page announcement describes No. 15 Nylon union check valve which installs easily in existing piping.—Jordan Corp., Div. of OPW Corp. 6013 Wiehe Rd., Cincinnati 13, Ohio.

Circle **609** on inquiry card.

TEMPERATURE

TEMPERATURE SWITCHES. 4-page brochure, "Got a Temperature Control Problem?" discusses applications of Thermoswitches.—Fenwal Inc., Ashland, Massachusetts.

Circle **610** on inquiry card.

COOLING-EFFECT DETECTION SYSTEMS. 4-page Bulletin F-8512 describes temperature control system which reduces engine power required to provide air-cooling of critical equipment.—Barber-Colman Co., 1300 Rock St., Rockford, Ill.

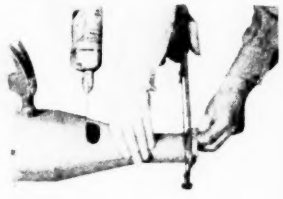
Circle **611** on inquiry card.

INDICATING TEMPERATURE CONTROLLER. New 4-page Bulletin 320 gives features and applications (heating and cooling) of new "Loewy-designed" Model MFS indicating temperature controller with 2- or 3-wire control circuits.—The Partlow Corp., New Hartford, N. Y.

Circle **612** on inquiry card.

FERNETIC CO-NETIC MAGNETIC SHIELDING

Non-Shock Sensitive, Non-Retentive, No Periodic Annealing, Shaped to Your Application



Permanently unaffected by shock or vibration from usage, drilling, cutting, punching, bending, etc. For maximum effectiveness, all possible joints are heliarc welded. Sheds magnetic forces like a duck's back sheds water. Will not become magnetized. Permanently non-retentive — negligible residual magnetism. No periodic annealing required.

Provides simultaneous high and low intensity shielding as well as high and low frequency shielding or any one of them. Aids miniaturization by making possible placing components close together, even mounted on the shield itself. Can be furnished tinned, ready for soldering—without affecting shielding qualities. Available as raw material if desired for fabricating parts in your own plant.

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For more information circle **127** on inquiry card.

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For more information circle **128** on inquiry card.

INDUSTRIAL RADIOMETER. 4-page Infrared Bulletin 1210 describes new Model R-4D1 OpticTherm designed to meet requirements of field, lab, mill and factory.—Barnes Engineering Co., 30 Commerce Rd., Stamford, Conn.

Circle **613** on inquiry card.

THERMAL CONDUCTIVITY CELL. 8-page bulletin discusses in technical detail the new Model 75 with its automatic temperature controller.—Barnes Engineering Co., 30 Commerce Rd., Stamford, Conn.

Circle **614** on inquiry card.

DIAL THERMOMETERS. 2-page bulletin describes line of straight-form thermometers for use on top of tanks, boilers, etc.— W. C. Dillion & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

Circle **615** on inquiry card.

RADIATION MEASUREMENT. 24-page catalog covers extensive line of thermopiles, thermocouples, and accessories for infrared, also for visible and ultraviolet.—Charles M. Reeder & Co., 173 Victor Ave., Detroit 3, Michigan.

Circle **616** on inquiry card.

HIGH-TEMPERATURE SWITCH. Data Sheet 140 describes new V3 small high-capacity high-temperature switch.—Micro Switch, Div. of Minneapolis-Honeywell Reg. Co., Freeport, Ill.

Circle **617** on inquiry card.

BEARING-OVERHEAT WARNING. 2-page bulletin describes Temperature Acceleration Indicator which gives alarm allowing machine to be shut down before bearing failure.—Lycoming, Div. of Avco Mfg. Corp., 550 S. Main St., Stratford, Conn.

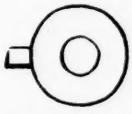
Circle **618** on inquiry card.

THERMAL DEVICES. Binder contains catalog sections totaling about 100 pages, on Klixon thermostats, overheat protectors, precision switches, circuit breakers, etc.—Spencer Thermostat Div., Metal & Controls Corp., Attleboro, Mass.

Circle **619** on inquiry card.

TEMPERATURE INSTRUMENTS. 4-page condensed catalog YSI-50-1257 describes complete-line of remote-indicating thermometers, thermistor probes and temperature controllers.—Yellow Springs Instrument Co., P. O. Box 106, Yellow Springs, Ohio.

Circle **620** on inquiry card.



FLOW

FLOWMETERS. 8-page Specification Sheet PM-10002 covers Series 3000 Ring Balance Meters and available accessories.—Hagan Chemicals & Controls, Inc., Hagan Bldg., Pittsburgh 30, Pa.

Circle **621** on inquiry card.

FLOWMETER DATA. 22-page Bulletin F1607 on differential-pressure type flow meters gives basic information and theory on selection, sizing and installation of various types of primary devices; includes tables of data for flow calculations.—The Bristol Co., Waterbury 20, Conn.

Circle **622** on inquiry card.

FLUID FLOW RATE ALARMS for signalling or simple control functions are described in 4-page Bulletin 165 on magnetic and electronic types for use with rotameters.—Brooks Rotameter Co., Lansdale, Penna.

Circle **623** on inquiry card.

CONTROL OF LEVELS. 16-page illustrated booklet describes in detail applications of company's capacitance-type devices in quantitative measurement and control of granular solids, liquids, powders and interface.—Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Phila. 33, Pa.

Circle **624** on inquiry card.

PRESSURE, WEIGHT

DIAPHRAGM SEALS. 2-page bulletin describes "Brookseals" designed to protect pressure gages against corrosion and clogging.—Brooks Rotameter, Co., P.O. Box 432, Lansdale, Penna.

Circle **625** on inquiry card.

HIGH-PRECISION PRESSURE GAGES. 4-page brochure describes new automatic compensation for variations in ambient temperature.—Heise Bourdon Tube Company, Inc., Brook Rd., Newtown, Conn.

Circle **626** on inquiry card.

OPTICS

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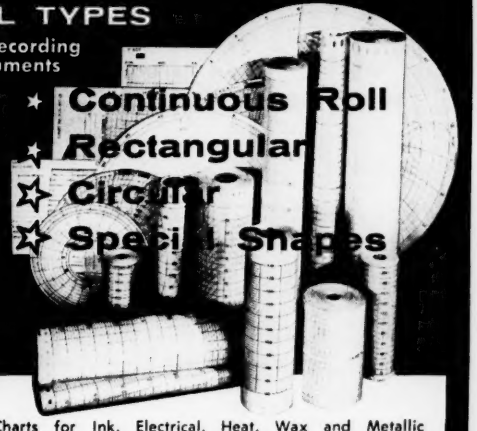

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PRESSURE SWITCH, sub-miniature, for absolute air pressure, 5 to 1000 cps vibration spectrum is described and specified in 2-page leaflet.—Newark Controls Co., 15 Ward St., Bloomfield, N. J.

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PRESSURE PICKUPS. 2-page Bulletin No. 4 describes variable-resistance types with diaphragm-capsule or Bourdon-Tube pressure-responsive elements, for absolute, gage and differential pressures.—Colvin Labs., Inc., 364 Glenwood Ave., E. Orange, N. J.

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BALANCES. 4-page Bulletin 56 describes Right-A-Weigh analytical balance featuring built-in weights of new NBS Class S tolerance, and fast-projection reading from 0.1 mg to 100 mg.—Announcement describes Underwriters' approved explosion-proof modification.—Wm. Ainsworth & Sons, Inc., 2151 Lawrence St., Denver 5, Colo.

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QUARTZ BALANCES. 8-page catalog covers helix, cantilever and torsion types utilizing fused quartz for adaptability, absence of hysteresis, temperature-resistance, and other unique advantages.—Microchemical Specialties Co., 1834 University Ave., Berkeley 3, Calif.

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TIME, SPEED, COUNT

PRESET ADD-SUBTRACT COUNTER. 2-page Bulletin No. 740 describes a new counter for count control between two limits, actuated by "add" and "subtract" pulses.—Eagle Signal Corp., 202 20th St., Moline, Ill.

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ELECTRONIC TACHOMETER. 2-page bulletin describes Model ET-1 with a no-contact pickup using pulses of light to produce electrical pulses which are fed to an electronic ratemeter.—Southwestern Industrial Electronics Co., 2831 Post Oak Rd., P. O. Box 13058, Houston, Texas.

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REPEAT CYCLE TIMERS. 2-page Bulletin AWH RC-301 describes new line of sub-miniature hermetically-sealed units offered with a variety of motors and up to 10 switches.—The A. W. Haydon Co., 232 Elm St., Waterbury 32, Conn.

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SYNCHRONOUS MOTOR. 2-page Bulletin PB-117 offers technical, operational, and design data on all five forms of new Type 117 Series.—Cramer Controls Corp., Centerbrook, Conn.

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OPTICAL

OPTICS, etc. 80-page Catalog 579 covers industrial and scientific optical instruments of thirty-odd types; also lenses, prisms, filters, etc.; also accessories such as lamps, small tools, etc.—Edmund Scientific Co., 101 E. Gloucester Pike, Barrington, N. J.

Circle **636** on inquiry card.

UV-VISIBLE MICROSCOPE. Bulletin #102 describes new Model ME-401 Monochrome TV Ultraviolet-Visible Microscope and Absorption Analyzer with monochromater adjustable from 2300A to 600A and TV camera utilizing UV-Vidicon tube.—Neutronics Research Co., 165 Lake St., Waltham, Mass.

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PRECISION OPTICS. 4-page Bulletin 737 covers lenses, prisms and other optical elements.—Plummer and Kershaw, 2759 Frankford Ave., Philadelphia 34, Pa.

Circle **638** on inquiry card.

METALLURGICAL MICROSCOPE. 8-page Brochure SB 2200 describes new Metalstar simple-to-use tool for study, measurement and photo-micrography of opaque specimens.—American Optical Co., Box A, Buffalo 15, N. Y.

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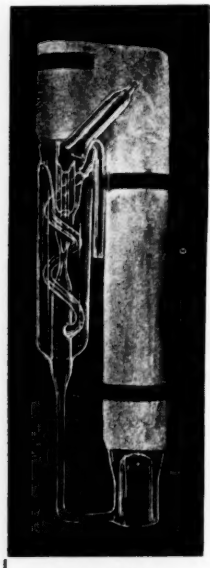

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STEAM, AIR

CONDENSERS. 8-page Bulletin 5AB describes low-level eductor and multi-jet condensers which discharge directly into a hotwell; contains application, construction, and operation information on both types.—Dept. JA-10, Schutte and Koerting Co., Cornwells Heights, Bucks County, Penna.

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PIPE LINE FILTERS for air and other gases are contained in 4-page Bulletin 200, describing "Staynew" units.—Dollinger Corp., 11 Centre Park, Rochester 3, N. Y.

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LABORATORY, ANALYTICAL

pH CONTROL in industrial waste treatment. 12-page reprint of a technical paper by Thomas J. Kehoe.—Scientific Instrument Div., Beckman Instruments, Inc., Fullerton, Calif.

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LAB EQUIPMENT. 20-page 31st edition of "What's New for the Laboratory" illustrates and describes thirty instruments and accessories.—Scientific Glass Apparatus Co., Inc., 100 Lakewood Ter., Bloomfield, N. J.

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LAB STOPCOCK. 4-page Bulletin 101 describes Vari-Flo, an entirely new precision-type stopcock providing infinite flow control of liquids and gases while covering a broad range of flow rates.—Wilmad Glass Co., Landisville, New Jersey.

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LAB BATHS. 4-page brochure describes general-purpose serological water baths for Wasserman, Kolmer, and Kahn tests, inactivations, serologic technique, ASTM and general purpose methods, etc.—National Appliance Co., 7634 S. W. Capitol Hwy., Portland 19, Oregon.

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LAB EQUIPMENT. 16-page Issue 2-57 of "Will Lab Log" illustrates and describes new fraction collectors for chromatography; single-pan balances; drying oven that can be hung on a wall; a new flow cell for pH measurements; and many other laboratory aids.—Will Corp., P. O. Box 1050, Rochester 3, N. Y.

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LAB EQUIPMENT. 112-page 34th-Anniversary Catalog describes testing instruments for paint, paper, plastics, ceramics, food, leather, oil, rubber and other materials.—Gardner Lab, Inc., P. O. Box 5728, Bethesda 14, Md.

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PORTABLE OXYGEN ANALYZER with continuous indication, working on magnetic principle, is described in 2-page Bulletin 102-127.—Thermco Instrument Corp., U. S. #20, La Porte, Ind.

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DATA HANDLING

SERVOSYSTEM ANALYZER WORK-SHEETS. Four transparent masters for duplication by photographic processes serve for permanent record on test results.—Servo Corporation of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y.

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DIGITAL COMPUTER ELEMENTS. Folder contains one 4-page and six 2-page bulletins on core-diode and core-transistor logical and register elements and shaping and driving units. Mack Electronics, Div. of Mack Trucks, Inc., 40 Leon St., Boston 15, Mass.

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DATA HANDLING. Series of three 2-page bulletins describe CMS-2 Monitor group which provides quick look data observation of up to 86 data sources at a glance.—2-page bulletin describes new GLH-2 Multicoder for operational and static testing.—Applied Science Corp. of Princeton, P. O. Box 44, Princeton, N. J.

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AN-DIG COMPUTER LINKAGE. 2-page bulletin describes new low-cost 2-channel "Addaverter" which enables combining the advantages of digital computers with the speed and programming convenience of analog machines.—Epsco Inc., 588 Commonwealth Ave., Boston 15, Mass.

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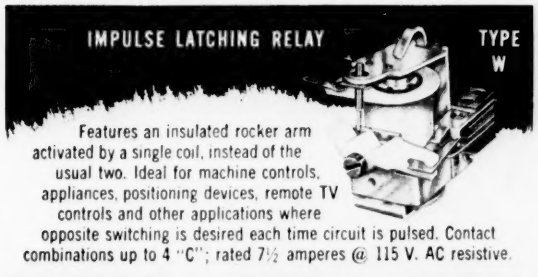

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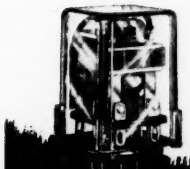

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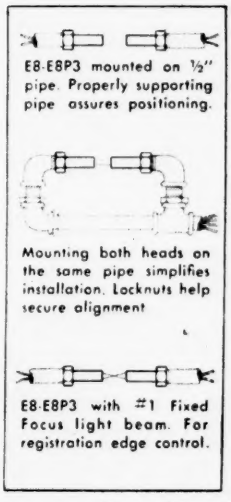
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NEW LITERATURE

DIGITAL TAPE SYSTEM. 16-page brochure gives thorough description of new Ampex system processing 30,000 to 90,000 characters per second depending on choice of tapes.—Ampex Corp., 934 Charter St., Redwood City, Calif.

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AN-DIG CONVERTERS. Three specification sheets: on Model P Phototron applicable to any type of coding; on Models C3-10 and C-4 with digital capacities of 999.9 and 9999 respectively and 1000-rpm stop-motion count rate.—Jones & Wettlaufer Engineering Corp., 11780 W. Pico Blvd., Los Angeles 64, Calif.

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TRANSISTORIZED COMPUTER. 4-page Newsletter gives specifications of new large-scale Transac S-2000 for business and scientific data processing.—Philco Corp., 4700 Wissahickon Ave., Phila. 44, Pa.

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CONVERTER, Model B-617 "Datrac", voltage-to-digital, is illustrated and described in new 6-page Engineering Data bulletin.—Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass.

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DATA HANDLING SYSTEMS. 4-page Technical Bulletin No. 103 describes a completely solid-state digital computer and input, programming and output facilities, specially designed for process monitoring and control. —4-page Technical Bulletin No. 104 describes transistorized magnetic-core information-storing systems combining random-access with large storage capacity per unit volume.—Daystrom Systems, Div. of Daystrom, Inc., 5640 La Jolla Blvd., La Jolla, Calif.

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RECORDERS

ELECTRONIC RECORDER for flow, level, temperature, pressure, and electrical quantities based on ring-balance principle is subject of new 4-page Bulletin MSP-149.—Hagan Chemicals & Controls, Inc., Hagan Building, Pittsburgh 30, Pa.

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RATIO RECORDER for two electrical signals (such as produced by tachometer generators) is described in 2-page Data Sheet 156.—Phoenix Precision Instrument Co., 3803 N. Fifth St., Phila 40, Pa.

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ELECTROLYTIC CONDUCTIVITY RECORDER. 4-page brochure describes completely-portable battery-operated instrument for use where electric power unavailable.—Industrial Instruments Inc., 89 Commerce Rd., Cedar Grove, N. J.

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SHIPPING SHOCK RECORDER. Announcement of Model SR-1, smaller than a cigarette pack, easily attached inside a shipping case. Range 5 to 150 G, set by knob.—Dynamic Measurements Corp., P. O. Box 4067, Pasadena, Calif.

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POTENTIOMETER RECORDERS. multipoint, for thermocouple or radiation pyrometer sensing are specified in 2-page Bulletin F-7955-1.—Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill.

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RECORDERS. Indicators and Accessories of makers of Speedomax instruments are described in 48-page Technical Publication ND 46 titled "New Horizons with Speedomax".—Leeds & Northrup Co., 4955 Stenton Ave., Phila. 44, Pa.

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INSPECTION, GAGING

COMPARATOR GAGES. 4-page Issue No. 12-1957 of "Precise Production" describes Comparitrol models for various dimensional inspection purpose.—George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.

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HEIGHT GAGE. 2-page bulletin describes new Tumico Optic Vernier height gage reading easily to 0.001"; adjusted in five seconds.—George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.

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AUTO COLLIMATOR to INSPECT DIMENSIONS to one second of arc or 5 millionth of an inch, and description of applications are subject of new 4-page bulletin.—George Scherr Co., Inc. 200 Lafayette St., New York 12, N. Y.

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TESTING FACILITIES for flight simulation; altitude and high-low temperature; shock, etc. are illustrated and described in new 4-page brochure.—American Laboratories, Div. of Am. Electronics, Inc., 1536 E. Ross Ave., Fullerton, Calif.

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ELECTRICAL, ELECTRONIC INSTRUMENTS

SUPERVISORY CONTROL. 16-page Bulletin GEA-6603 describes functions ranging from opening and closing of switches and valves, to adjustments of speed, voltage or load.—General Electric Co., Schenectady 5, N. Y.

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VARIABLE TRANSFORMERS. 2-page Bulletin 151 describes first model in new line of "V.T." variable transformers, the "VT1R5" (1.5 amp) unit said to be the most advanced in industry.—Ohmite Mfg. Co., 3668 Howard St., Skokie, Ill.

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AMPLIFIER. 2-page bulletin describes Universal Stabilized Amplifier Model USA-3, said to be unique in that user can obtain output characteristics best suited to his application.—George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.

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SATURABLE REACTORS. 4-page Bulletin C-15 describes proportioning reactors, transducers, and switching reactors.—Control, a division of Magnetics, Inc., Butler, Penna.

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ELECTRONIC INSTRUMENTS. Five 2-page bulletins describe: Transistor Decade Amplifier, Model 6000 (Bull. 501); Power Amplifier, Model 6006. (Bull.502); Laboratory Standard Microphone, Model 6100 (Bull.503); Logarithmic Translator, Model 6700 (Bull.504); and Magnetizer, Model 6800 (Bull.505).—E V. Instruments, a division of Electro-Voice, Inc., Buchanan, Mich.

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SCIENTIFIC INSTRUMENTS. Two new 2-page bulletins describe application, operation, circuit, accuracy, etc. of voltage dividers (Bull. 105); and transmitter and resolver bridges (Bull. 106).—Gray Instrument Co., 200 East Church Lane, Phila. 44, Pa.

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MULTI-RANGE ELECTRICAL INDICATOR. 2-page leaflet describes new German-made Elavi-1 with 21 ranges for ac, dc and resistance.—EPIC, Inc., 154 Nassau St., New York 38, N. Y.

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DISPLACEMENT PICKUPS. 4-page technical bulletin describes Series 2242, of variable-resistance type, with 1" stroke and accuracy of 0.001" these pickups mount interchangeably with mechanical dial indicators.—Colvin Laboratories, Inc., East Orange, N. J.

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TRANSISTORIZED EQUIPMENT. 10-page file-drawer folder type catalog covers ERA's complete line of products, including transistorized inverters converters and power supplies, transistor test equipment, etc.—Electronic Research Associates, Inc., 67 Factory Place, Cedar Grove, N. J.

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PULSE CODE GENERATORS for design and test of memory components and digital logic are subject of 4-page Catalog 5100A.—Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.

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PHASE METERS. delay lines and counters are described in new 4-page bulletin.—Ad-Yu Electronics Lab., Inc., 249 Terhune Ave., Passaic, N. J.

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TRANSISTORS

TRANSISTOR MANUFACTURING. 8-page brochure shows how the germanium-alloyed junction transistor is manufactured from raw material to finished product.—General Transistor Corp., 91-27 138th Place, Jamaica 35, N. Y.

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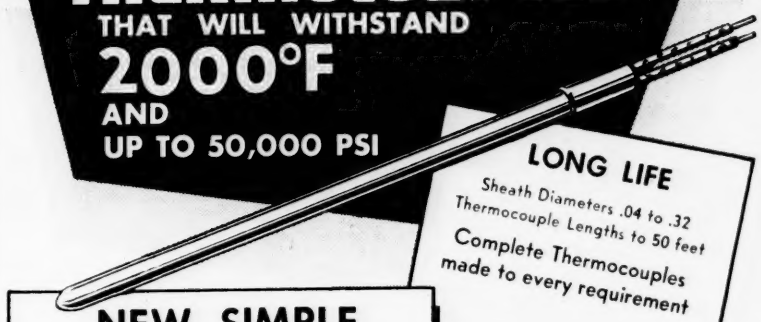

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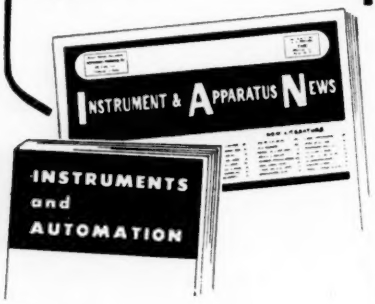

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NEW LITERATURE

SILICON SWITCHING DIODE. 4-page bulletin describes new Shockley 4-layer npnp Silicon Diode, discusses theory and function of device, includes application diagrams.—Shockley Semi-conductor Lab., Beckman Instruments, Inc., Mountain View, Calif.

Circle **680** on inquiry card.

RELAYS, SWITCHES

TIME DELAY RELAYS. 2-page Bulletin AWH TD-502 describes new line of sub-miniature hermetically-sealed units for aircraft, missile and rocket applications, also for industry where space and weight are at a premium.—The A. W. Haydon Co., 232 N. Elm St., Waterbury 32, Conn.

Circle **681** on inquiry card.

CONTACTORS AND RELAYS. 32-page Catalog GEA-6621 covers company's complete line of d-c contactors and relays; provides extensive selection and application data.—General Electric Co., Schenectady 5, N. Y.

Circle **682** on inquiry card.

TIME DELAY RELAYS, series T100-T300, T500, and T700, all-electronic, transistorized, are subject of new 4-page Technical Data Sheet 1357.—Tempo Instrument Incorporated, 240 Old Country Rd., Hicksville, N. Y.

Circle **683** on inquiry card.

CONTROL RELAY. 2-page bulletin describes new two-level Model 219 for use with load cell, especially suitable for checkweighing, sorting into weight groups, etc.—Avion Div., ACF Industries Inc., 11 Park Place, Paramus, N. J.

Circle **684** on inquiry card.

RELAYS. Binder contains a total of 46 pages of descriptions and specifications of 18 types of relays.—Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill.

Circle **685** on inquiry card.

RELAYS AND CONTACTORS. 32-page condensed catalog (December 1957) gives specifications and characteristics of hundreds of relays, contactors and associated devices.—Universal Relay Corp., 42 White St., New York 13, N. Y.

Circle **686** on inquiry card.

POWER SUPPLIES

POWER SUPPLY. Bulletins 93 and 96, 2 pages each, describe new Aircraft Battery Substitutes delivering 0-32 vdc @0-5 amp, and 0-10 amp, respectively.—Opad Electric Co., 69 Murray St., New York 7, N. Y.

Circle **687** on inquiry card.

POWER SUPPLIES. 12-page file-drawer folder contains catalog sheets on standard line of electronically regulated laboratory power supplies.—Trans Electronics, Inc., 7349 Canoga Ave., Canoga Park, Calif.

Circle **688** on inquiry card.

ELECTRICAL, ELECTRONIC COMPONENTS

SLIP-RING ASSEMBLIES. 8-page brochure describes and pictures over 50 slip rings, brushes, commutators and drums.—Slip Ring Company of America, 3612 W. Jefferson Blvd., Los Angeles 16, Calif.

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TRANSFORMERS. New 28-page Catalog No. 102 lists, illustrates, and describes 390 types of transformers.—Hermetic Seal Transformer Co., 555 North Fifth St., P. O. Box 277, Garland, Texas.

Circle **690** on inquiry card.

MINIATURE INDICATORS, transistor circuit and switch-light indicators are described in 6-page brochure.—Eldema Corp., 1805 Belcroft Ave., El Monte, Calif.

Circle **691** on inquiry card.

CAPACITORS. 6-page catalog covers polystyrene, polyethylene, Teflon and Mylar dielectric capacitors and HV power supplies.—Film Capacitors, Inc., 3400 Park Ave., New York 56, N. Y.

Circle **692** on inquiry card.

SOLENOIDS. 6-page condensed Catalog 572 illustrates and gives force characteristics of every Decco industrial solenoid model.—Detroit Coil Co., 2435 Hilton Rd., Ferndale 20, Mich.

Circle **693** on inquiry card.

ELECTROMECHANICAL COMPONENTS. 32-page catalog covers relays, steppers, solenoids, rectifiers and other electronic components.—Universal Relay Corp., 42 White St., New York 13, N. Y.

Circle **694** on inquiry card.

PLASTIC CLAMPS. 2-page catalog insert describes and gives specifications of Saran, Nylon, and ethyl cellulose clamps in loop, stays and other forms.—Holub Industries, Inc., Sycamore, Ill.

Circle **695** on inquiry card.

TERMINAL BLOCKS. 4-page Publication 143 describes molded-barrier-type blocks, miniature power outlets, electronic switches, etc.—Kulka Electric Corp., 633-640 So. Fulton Ave., Mount Vernon, N. Y.

Circle **696** on inquiry card.

FABRICATION

WINDING MACHINES. 2-page catalog sheet illustrates and gives condensed descriptions of eight coil-winding machines.—Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill.

Circle **697** on inquiry card.

METAL PUTTY. 4-page brochure describes "Flawmaster," the original Epoxy-based compound metal putty, used to fill blowholes in castings, to eliminate nicks and scratches, machining flaws and porous areas in precision metal parts.—Carl H. Biggs Co., 2255 Barry Ave., W. Los Angeles 64, Calif.

Circle **698** on inquiry card.

PRINTED CIRCUIT FACILITIES. 4-page brochure describes modern methods by which this specialized development is produced.—Electralab, Inc., Industrial Center, Needham Heights 94, Mass.

Circle **699** on inquiry card.

TAPPING MACHINE. 2-page bulletin describes multiple-pitch automatic lead screw machine for automatic tapping of all standard threads 32 to 80.—Milman Engineering Co., 1831 Pontius Ave., Los Angeles 25, Calif.

Circle **700** on inquiry card.

ELECTRIC FURNACES. Specification sheets describe new line of Atmo-Carb controlled-atmosphere electric furnaces.—L&L Mfg. Co., 136 Eighth St., Upland, Delaware County, Penna.

Circle **701** on inquiry card.

MISCELLANEOUS

MINIATURE COUPLINGS. 4-page Bulletin MC-100 covers miniature couplings for use on servo-mechanisms, computers, missiles, etc.—Thomas Flexible Coupling Co., Warren, Penna.

Circle **702** on inquiry card.

COUNT-CONTROL CONTAINERS. 2-page bulletin and explanatory letter describe Ready Count Containers which reduce arm-reach motions to finger-reach and also offer advantages in the operation of automatic machines.—Alden Systems Co., Washington St., Westboro, Mass.

Circle **703** on inquiry card.

SMALL TUBING.—4-page brochure describes close-tolerance line for industrial uses, available in sizes from $\frac{7}{8}$" OD down to 0.010" OD.—Precision Tube Company, Inc., North Wales, Penna.

Circle **704** on inquiry card.

EDUCATIONAL KITS. 6-page brochure describes seven types of Electri-Kits for learning electricity and electronics "at every educational level."—Crow Electri-Craft Corp., Div. of Universal Scientific Co., Inc., 1102 Shelby St., Vincennes, Ind.

Circle **705** on inquiry card.

SPRING PINS for mechanical, electrical and electronic applications are tabulated, described and priced in 12-page bulletin.—C.E.M. Company School St., Danielson, Conn.

Circle **706** on inquiry card.

WEATHERPROOF METER HOUSES. 12-page catalog covers standard, multi-door, horizontal, portable walk-in, etc., meter houses.—Moran Furnace and Sheet Metal Co., Tulsa, Oklahoma.

Circle **707** on inquiry card.

POCKET TOOLS. Two pocket-size folders describe scribers, pocket magnets, etc.—Spring Specialty Co., 23 N. 5th Ave., Maywood, Ill.

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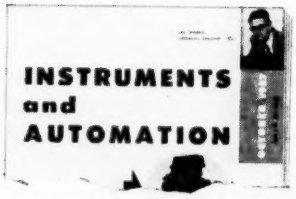

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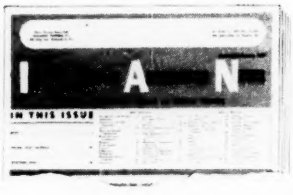

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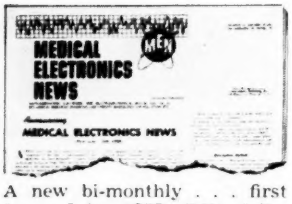

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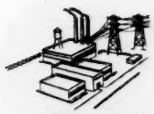

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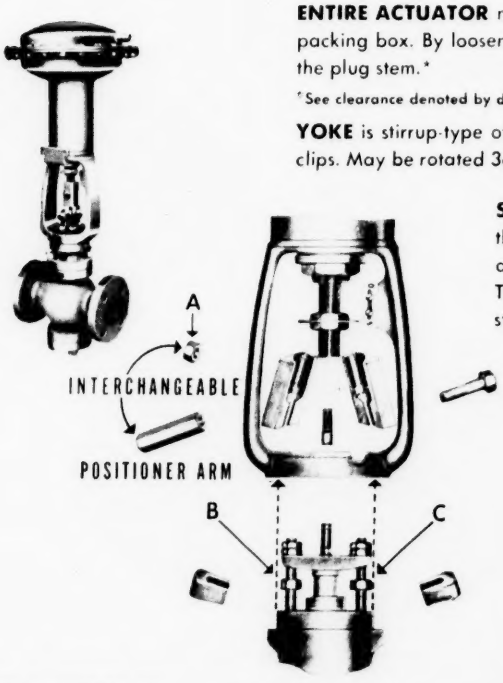

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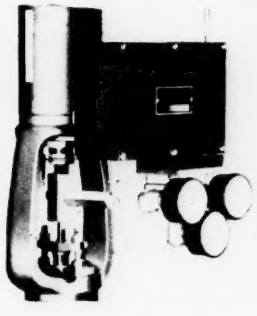

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